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**Agricultural and Physiological Laboratory of the Massachusetts State Agricultural Station, Amherst, Mass.**

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PUBLIC DOCUMENT.

No. 33.

**SEVENTH ANNUAL REPORT**

OF THE

**BOARD OF CONTROL**

OF THE

**STATE AGRICULTURAL EXPERIMENT  
STATION**

AT

**AMHERST, MASS.**

**1889.**

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*The State*

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1823



**Chemical Laboratory of the Massachusetts State Experiment Station, Amherst, Mass.**

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production of milk and of pork have been continued, with some modifications; to these have been added of late experiments to ascertain the cost of feed for the production of beef and mutton. A variety of field crops, in particular reputed fodder crops, have been raised for testing their relative feeding value, and to determine their general merits in a mixed farm management. Some of these crops suffered, in common with our grain crops, from exceptionally cool and wet weather during the latter part of June and the months of July and August.

The laboratory work has been exceptionally large and in various directions, in consequence of the additional chemical work called for by the Hatch Experiment Station, and by the State inspection of commercial fertilizers; aside from the numerous applications of farmers, associations, and parties interested in farming, for the examination of fertilizers, fodder articles, well-waters, etc.

The details of the work carried on in the previously stated directions are recorded in the subsequent pages under the following headings: —

### FEEDING EXPERIMENTS.

I. Feeding experiments with milch cows, to ascertain the feeding value of fodder corn, corn stover and corn ensilage, as compared with English hay, and also of sugar beets and of carrots.

II. Feeding experiments with milch cows, to ascertain the value of a mixed crop of vetch and oats, of Southern cow-pea and of serradella, when fed as green fodder in part or in the whole for English hay.

III. Financial record of twelve cows, kept at the Massachusetts Experiment Station.

IV. Creamery record of the station during the years 1887, 1888 and 1889; with some observations made during several visits to the farms of one hundred and ninety-three patrons of two creameries in our vicinity.

V. Feeding experiments with pigs; skim milk, barley meal, corn meal, wheat bran and gluten meal serving as fodder ingredients of the daily diet.

### FIELD EXPERIMENTS.

VI. Experiments to compare the effect of different forms of nitrogen on the growth, etc., of corn.



VII. Influence of fertilizers on the quantity and quality of fodder crops.

VIII. Experiments with field and garden crops.

IX. Experiments with green crops for summer feed.

X. Professor Humphrey's report:—

1. General account of fungi.
2. Potato scab.
3. Diseases on station farm.
4. Observations of material sent on for examination.

SPECIAL WORK IN THE CHEMICAL LABORATORY.

XI. Analyses of licensed commercial fertilizers.

XII. Miscellaneous analyses of material sent on.

XIII. Water analyses.

XIV. Compilation of fodder analyses, with reference to fodder constituents and fertilizing constituents; analyses of industrial products, garden crops, fruits, etc., made at Amherst, Mass.

XV. Meteorological observations.

The periodical publications of the station have been more numerous than in preceding years, on account of the monthly publications of the analyses of licensed fertilizers required by the new laws for the regulation of the trade of commercial fertilizers. Four bulletins, containing reports of progress on investigations, and six monthly circulars of fertilizer analyses, have been issued. The interest in the publications of the station is steadily growing. From ten to eleven thousand copies have been published of late.

It gives me particular pleasure to acknowledge the valuable assistance rendered by all parties engaged in the work of the station. To their marked industry and faithful execution of the various tasks assigned to them is largely due the successful termination of the work recorded in this report.

Thanking you sincerely for your kind indulgence in the performance of my duties, permit me to sign,

Yours very respectfully,

C. A. GOESSMANN,

*Director of the Massachusetts Agricultural Experiment Station.*

## ON FEEDING EXPERIMENTS.

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I. Feeding experiments with milch cows, to determine the value of fodder corn, corn stover and corn ensilage, as compared with English hay; and also of corn ensilage, as compared with that of sugar beets and carrots. The statement closes with a summary of observations in that connection during four successive years, 1885 to 1889.

II. Feeding experiments with milch cows, to ascertain the value of vetch and oats, of cow-pea and of serradella when fed as green fodder in part or in the whole for English hay. The results reported are those of the third year of our trial.

III. Record of twelve cows kept at the Massachusetts Experiment Station.

IV. Creamery record of the station during the years 1887, 1888 and 1889; and some observations made during visits to the patrons of two creameries in our vicinity.

V. Feeding experiments with pigs; skim-milk, barley meal, corn meal, wheat bran and gluten meal serving as fodder ingredients of the daily diet.

VI. Fodder analyses.

I. RECORD OF FEEDING EXPERIMENTS WITH MILCH COWS, TO DETERMINE THE RELATIVE VALUE OF FODDER CORN, CORN STOVER AND CORN ENSILAGE, AS COMPARED WITH THAT OF ENGLISH HAY; AND OF CORN ENSILAGE AS COMPARED WITH THAT OF SUGAR BEETS AND OF CARROTS, UNDER OTHERWISE CORRESPONDING CIRCUMSTANCES. FOURTH YEAR OF OBSERVATION, FROM NOVEMBER, 1888, TO MAY, 1889.

The experiment was conducted upon the same general plan as during the preceding years, the principal object of the investigation remaining the same as stated above. A

larger number of cows (nine) than in any of the preceding years took part in the trial; not more, however, than six cows at any one time. Whenever the daily yield of milk of any particular animal fell below from six to seven quarts, on account of advanced milking period, a new-milch cow was substituted, to secure, as far as practicable, corresponding conditions throughout the entire experiment. Grades of various descriptions, yet of a similar quality with regard to the production of quantity and quality of milk, constituted our herd. They varied in age from five to eleven years; the mean in case of nine cows was seven years. Each served from two to seven months for our observation.

The course adopted in preparing the daily diet was essentially the same as in the preceding year. English hay, fodder corn, corn stover, corn ensilage, sugar beets and carrots served as coarse fodder articles; and corn meal, wheat bran and gluten meal as the supplementary feed stuffs to secure the desired relative proportion of digestible nitrogenous to non-nitrogenous substances in the daily fodder rations (commonly called nutritive ratio). The fodder corn, corn stover and corn ensilage were cut to an even length (one and one-half to two inches) before fed. The daily amount of fodder corn left behind unconsumed was, on an average, two and one-half pounds, and that of corn stover and ensilage about three pounds.

The same variety of corn, Pride of the North, a dent corn, served for each trial. The corn ensilage used on these occasions has been produced in every instance from a corn crop of the same variety and the same state of maturity as the one which furnished the dry fodder corn; *i. e.*, at the beginning of the glazing over of the kernels.

The experiment was subdivided into nine feeding periods, extending over a period of seven months. The same quantity of corn meal, wheat bran and gluten meal (three and one-quarter pounds each) was fed daily, from the beginning to the close of the trial. Corn ensilage and roots were fed in different proportions, with one-half or one-fourth of a full English hay ration. Fodder corn and corn stover were fed most of the time by themselves.

The quantity of different fodder rations stated below

#### 14 AGRICULTURAL EXPERIMENT STATION. [Jan.

represents in each case the daily average of the amount actually consumed per head during the entire feeding period. The variations in the daily consumption of the various ingredients of the daily diet in case of different animals were confined entirely to the fodder corn, the corn stover and the corn ensilage, when serving as substitutes in part or in the whole for hay; and to hay, when fed alone as the coarse or bulky part of the daily diet. The amount consumed in that case was controlled by the appetite of the animal, as somewhat larger quantities than the figures represent were offered for their consumption. The daily consumption of the grain feed was limited to the amount stated in each case; the same statement applies to the hay when fed in connection with some other coarse fodder articles, as corn ensilage, sugar beets, etc.

The nutritive ratio of the different diets used varied from 1 : 5.13 to 1 : 6.79. The adopted rates of digestibility of the fodder ingredients are those which have been published of late by E. Wolff. They are in most instances the average values of a series of actual tests, and are for this reason applicable for mere economical questions. As soon as our home observations shall have furnished sufficient material to enable us to establish reliable average values, they will be substituted.

The temporary changes in diet, whenever decided upon, were carried out gradually, as is customary in all carefully conducted feeding experiments. At least five days are allowed in every instance to pass by, in case of a change in the character of the feed, before the daily observations of the results appear in our published records. The dates, which accompany all detailed reports in our feeding experiments, past and present, furnish exact figures in that direction. This is in particular the case whenever such statements are of a special interest, for an intelligent appreciation of the final conclusions presented.

The weights of the animals were taken on the same day of each week, before milking and feeding.

The valuation of fodder ingredients is based, in this connection, on the local market price per ton of each article for the period of observation.

Corn meal, . . .	\$21 90	Fodder corn, . . .	\$5 00
Wheat bran, . . .	20 70	Corn stover, . . .	5 00
Gluten meal, . . .	23 40	Corn ensilage, . . .	2 75
Hay, . . .	15 00	Carrots, . . .	7 00
Rowen, . . .	15 00	Sugar beets, . . .	5 00

The commercial valuation of the fertilizing constituents contained in each fodder article is based on the following market prices: *i. e.*, nitrogen (per pound), 17 cents; phosphoric acid, 6 cents; and potassium oxide,  $4\frac{1}{2}$  cents. Eighty per cent. of the entire amount of fertilizing constituents contained in the fodder consumed is considered obtainable by proper management; while twenty per cent. is assumed to be sold with the milk, and thus lost to the farm.

The obtainable manurial value of the feed consumed during the entire feeding experiment, deducting twenty per cent. for the amount of fertilizing constituents lost in the production of milk, is, at the current market rates, in every instance, more than equal to one-third of the original cost of the feed. In some instances it amounts to more than one-half of the original cost of the feed consumed.

Net cost of feed represents the sum obtained by subtracting eighty per cent. of the commercial value of the fertilizing constituents contained in the fodder consumed, from the total cost of the feed. Nothing but the net cost of feed is considered in the discussion of the cost of production of milk and of cream.

An examination of the subsequent detailed description of the experiment under consideration leads to the same conclusions as our observations in this direction during preceding years: —

1. The high nutritive value of fodder corn, corn stover and good corn ensilage, as compared with that of English hay, counting in all instances pound for pound of dry vegetable matter, is fully confirmed. The general condition of the animal on trial, as well as the quality and the quantity of the milk obtained, point in that direction.

2. To produce one quart of milk, using the same quantity and quality of grain feed, required in every instance a larger quantity of perfectly dried hay than of either fodder

corn, corn stover or corn ensilage in a corresponding state of dryness, — corn stover leading.

3. The net cost of feed in the case of the same ration of grain feed is from one-third to one-half less per quart of milk, when fodder corn, corn stover or corn ensilage serve as substitutes for English hay in the daily diet of milch cows; corn fodder, as a rule, leading, while corn stover leads the corn ensilage in four out of six cases.

4. Sugar beets, as well as carrots, when fed pound for pound of dry matter in place of part of the hay ration, with the same kind and quantity of grain feed, have raised almost without an exception the temporary yield of milk; exceeding, as a rule, the corn ensilage in that direction.

5. Corn ensilage, as well as roots, proved best when fed in place of one-fourth to one-half of the full hay ration. From twenty-five to twenty-seven pounds of roots, or from thirty-five to forty pounds of corn ensilage, per day, with all the hay called for to satisfy the animal in either case, seems for various reasons a good proportion, allowing the stated kind and quantity of grain feed.

6. The influence of the various diets used on the quality of the milk seems to depend in a controlling degree on the constitutional characteristics of the animal on trial. The effect is not unfrequently in our case the reverse in different animals depending on the same diet. The increase in the quantity of milk is frequently accompanied by a decrease in solids.

*Quarts of Milk required to make One Space of Cream. (Average of Six Cows fed upon the Following Rations.)*

Hay Period.	Fodder Corn Period.	Corn Stover Period.	Carrot Period.	Corn Ensilage Period.	Sugar Beet Period.
1.98	1.68	1.59	2.16	1.92	1.88

For further details, consult the subsequent record of our experiment (November, 1888, to May, 1889), and also the summary of our investigations during 1885, 1886, 1887, 1888 and 1889, in connection with the subject under discussion.

**FEEDING RECORD.**  
*ANNIE: Age, six years; grade, Jersey; last calf, June 19, 1888.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.								Amount of Dry Matter consumed in the Daily Ration (pounds).	Quarts of Milk produced per day.	Pounds of Dry Matter per quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (pounds).
	Corn Meal.	Wheat Bran.	Oatmeal.	Hay.	Fodder Corn.	Corn Stover.	Carrots.	Corn Ensilage.	Sugar Beets.	Hooven.			
<b>1888 and 1889.</b>													
Nov. 1 to Nov. 15, .	3.25	3.25	3.25	18.67	—	—	—	—	—	—	10.68	2.42	880
Nov. 20 to Dec. 11, .	3.25	3.25	3.25	—	13.27	—	—	—	—	—	8.51	2.00	784
Dec. 17 to Dec. 27, .	3.25	3.25	3.25	—	—	14.36	—	—	—	—	7.09	2.23	766
Jan. 3 to Jan. 21, .	3.25	3.25	3.25	10.00	—	—	37.05	—	—	—	10.27	2.10	808
Jan. 29 to Feb. 19, .	3.25	3.25	3.25	5.00	—	—	—	29.91	—	—	10.10	2.07	806
March 1 to March 14, .	3.25	3.25	3.25	15.00	—	—	—	—	—	—	9.07	2.48	842
March 19 to April 2, .	3.25	3.25	3.25	10.00	—	—	—	—	43.53	—	10.28	2.28	847
April 9 to April 22, .	3.25	3.25	3.25	16.50	—	—	—	—	—	—	10.20	2.34	880
April 30 to May 21, .	3.25	3.25	3.25	—	—	—	—	—	—	16.64	10.42	2.25	888

**MAY: Age, eight years; grade, Jersey; last calf, June 6, 1887.**

Nov. 1 to Nov. 15, .	3.25	3.25	3.25	20.00	—	—	—	—	—	—	10.13	2.67	950
Nov. 20 to Dec. 11, .	3.25	3.25	3.25	—	17.68	—	—	—	—	—	8.05	2.46	907
Dec. 17 to Dec. 27, .	3.25	3.25	3.25	—	—	21.82	—	—	—	—	8.43	2.32	902
Jan. 8 to Jan. 21, .	3.25	3.25	3.25	10.00	—	—	39.37	—	—	—	9.53	2.29	892
Jan. 29 to Feb. 19, .	3.25	3.25	3.25	5.00	—	—	—	38.86	—	—	9.13	2.54	937
March 19 to April 2, .	3.25	3.25	3.25	10.00	—	—	—	—	43.33	—	9.64	2.43	980
April 9 to April 22, .	3.25	3.25	3.25	16.93	—	—	—	—	—	—	9.29	2.61	976
April 30 to May 21, .	3.25	3.25	3.25	—	—	—	—	—	—	18.05	10.01	2.47	962



## FEEDING RECORD — Continued.

EVA: Age, nine years; grade, Jersey; last calf, Oct. 7, 1888.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.								Amount of Dry Vegetable Matter contained in the Daily Ration consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Gluten Meal.	Hay.	Podder Corn.	Corn Slover.	Carrots.	Corn Ensilage.	Sugar Beets.	Rowen.			
1888 and 1889.													
Nov. 1 to Nov. 15.	3.25	3.25	3.25	20.00	—	—	—	—	—	—	14.95	1:6.22	1,018
Nov. 20 to Dec. 11.	3.25	3.25	3.25	—	18.23	—	—	—	—	—	11.76	1:5.70	972
Dec. 17 to Dec. 27.	3.25	3.25	3.25	—	—	19.00	—	—	—	—	10.84	1:6.00	941
Jan. 3 to Jan. 21.	3.25	3.25	3.25	10.00	—	—	89.85	—	—	—	12.18	1:6.20	964
Jan. 29 to Feb. 19.	3.25	3.25	3.25	5.00	—	—	—	43.00	—	—	11.58	1:6.79	980
March 1 to March 14.	3.23	3.25	3.25	20.43	—	—	—	—	—	—	10.78	1:6.25	1,025
March 19 to April 2.	3.25	3.25	3.25	10.00	—	—	—	—	46.20	—	10.99	1:6.14	992

MELIA: Age, eleven years; grade, Dutch; last calf, Aug. 5, 1887.

Nov. 1 to Nov. 15.	3.25	3.25	3.25	18.73	—	—	—	—	—	—	9.60	1:6.15	1,063
Nov. 20 to Dec. 11.	3.25	3.25	3.25	—	13.45	—	—	—	—	—	7.17	1:5.45	1,025
Dec. 17 to Dec. 27.	3.25	3.25	3.25	—	—	17.18	—	—	—	—	6.48	1:5.87	1,027
Jan. 8 to Jan. 21.	3.25	3.25	3.25	10.00	—	—	39.37	—	—	—	7.66	1:6.20	1,062
Jan. 29 to Feb. 19.	3.25	3.25	3.25	5.00	—	—	—	34.32	—	—	7.20	1:6.50	1,094

## FEEDING RECORD—Continued.

DAISY: Age, six years; grade, Durham; last calf, Jan. 5, 1888.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.										Amount of Dry Veg- etable Matter con- tained in the Daily (Pounds).	Quarts of Milk pro- duced per Day.	Pounds of Dry Mat- ter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Gluten Meal.	Hay.	Fodder Corn.	Corn Stover.	Carrots.	Corn Mealage.	Sugar Beets.	Rowen.					
1888 and 1889.															
Nov. 1 to Nov. 15, .	3.25	3.25	3.25	22.00	—	—	—	—	—	—	28.90	9.87	2.98	1: 6.34	1,164
Nov. 20 to Dec. 11, .	3.25	3.25	3.25	—	19.59	—	—	—	—	—	21.04	6.35	3.31	1: 5.81	1,168
Dec. 17 to Dec. 27, .	3.25	3.25	3.25	—	—	26.86	—	—	—	—	21.82	5.48	4.02	1: 6.44	1,170
Jan. 3 to Jan. 18, .	3.25	3.25	3.25	10.00	—	—	43.25	—	—	—	22.17	6.09	3.64	1: 6.26	1,195

MINNIE: Age, nine years; grade, Ayrshire; last calf, May 3, 1887.

Nov. 1 to Nov. 15, .	3.25	3.25	3.25	17.52	—	—	—	—	—	—	3.16	1: 6.07	1,051
Nov. 20 to Dec. 11, .	3.25	3.25	3.25	—	11.68	—	—	—	—	—	2.61	1: 5.33	1,016

FLORA: Age, five years; grade, Durham; last calf, Dec. 22, 1888.

Jan. 3 to Jan. 21, .	3.25	3.25	3.25	10.00	—	—	39.05	—	—	—	1.42	1: 6.20	900
Jan. 29 to Feb. 19, .	3.25	3.25	3.25	5.00	—	—	—	30.91	—	—	1.59	1: 6.38	862
March 1 to March 14, .	3.25	3.25	3.25	14.86	—	—	—	—	—	—	1.85	1: 5.39	877
March 19 to April 2, .	3.25	3.25	3.25	10.00	—	—	—	—	43.47	—	1.79	1: 6.11	873
April 9 to April 22, .	3.25	3.25	3.25	18.21	—	—	—	—	—	—	1.95	1: 6.12	917
April 30 to May 21, .	3.25	3.25	3.25	—	—	—	—	—	—	19.23	1.93	1: 5.21	918

## FEEDING RECORD — Concluded.

JESSIE: Age, five years; grade, Jersey; last calf, Jan. 12, 1889.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.										Amount of Dry Vegetable Matter contained in the Daily Ration (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Oat Meal.	Hay.	Podder Corn.	Corn Slover.	Carrots.	Corn Ensilage.	Sugar Beets.	Rowen.					
1888 and 1889.															
Jan. 29 to Feb. 19, .	3.25	3.25	3.25	5.00	—	—	—	42.09	—	—	23.98	14.12	1.70	1:6.76	735
March 1 to March 14, .	3.25	3.25	3.25	15.21	—	—	—	—	—	—	22.66	11.46	1.98	1:5.96	736
March 19 to April 2, .	3.25	3.25	3.25	10.00	—	—	—	—	47.47	—	23.94	11.73	2.04	1:6.16	784
April 9 to April 22, .	3.25	3.25	3.25	18.93	—	—	—	—	—	—	25.08	12.78	1.96	1:6.16	794
April 30 to May 21, .	3.25	3.25	3.25	—	—	—	—	—	—	20.27	26.72	13.23	2.02	1:5.24	800

ELSIE: Age, six years; grade, Dutch; last calf, Feb. 26, 1889.

March 19 to April 2, .	3.25	3.25	3.25	10.00	—	—	—	—	49.60	—	24.21	13.64	1.78	1:6.18	1,112
April 9 to April 22, .	3.25	3.25	3.25	21.32	—	—	—	—	—	—	28.27	12.25	2.31	1:6.30	1,115
April 30 to May 21, .	3.25	3.25	3.25	—	—	—	—	—	—	23.45	29.55	12.33	2.39	1:5.31	1,128

## TOTAL COST OF FEED PER QUART OF MILK.

Anné.

FEEDING PERIODS.	Total Quantity of Milk produced.	Average Daily Yield of Milk.	1886 and 1889.										Total Amount of Hay consumed.	Total Amount of Corn consumed.	Total Amount of Clover consumed.	Total Amount of Carrots consumed.	Total Amount of Corn Mealage consumed.	Total Amount of Sugar Beets consumed.	Total Amount of Rowen consumed.	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk.
			Total Amount of Corn consumed.	Total Amount of Wheat Bran consumed.	Total Amount of Gluten Meal consumed.	Total Amount of Hay consumed.	Total Amount of Corn consumed.	Total Amount of Clover consumed.	Total Amount of Carrots consumed.	Total Amount of Corn Mealage consumed.	Total Amount of Sugar Beets consumed.	Total Amount of Rowen consumed.									
Nov. 1 to Nov. 15.	160.25	10.68	48.75	48.75	48.75	280.00	—	392.00	—	—	—	—	—	—	—	—	—	—	—	\$3 71	2.32
Nov. 20 to Dec. 11.	187.25	8.51	71.50	71.50	71.50	—	—	—	—	158 00	—	—	—	—	—	—	—	—	—	3 11	1.66
Dec. 17 to Dec. 27.	78.00	7.09	35.75	35.75	35.75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1 58	2.02
Jan. 3 to Jan. 21.	195.25	10.27	61.75	61.75	61.75	190.00	—	—	—	—	—	—	—	—	—	—	—	—	—	5 93	3.04
Jan. 29 to Feb. 19.	222.25	10.10	71.50	71.50	71.50	110.00	—	—	—	—	—	—	—	—	—	—	—	—	—	4 09	1.84
March 1 to March 14.	127.00	9.07	45.50	45.50	45.50	210.00	—	—	—	—	—	—	—	—	—	—	—	—	—	3 08	2.43
March 19 to April 2.	154.13	10.28	48.75	48.75	48.75	150.00	—	—	—	—	—	—	—	—	—	—	—	—	—	4 37	2.84
April 9 to April 22.	142.75	10.20	45.50	45.50	45.50	231.00	—	—	—	—	—	—	—	—	—	—	—	—	—	3 23	2.26
April 30 to May 21.	229.25	10.42	71.50	71.50	71.50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5 10	2.22
May.																					
Nov. 1 to Nov. 15.	152.00	10.13	48.75	48.75	48.75	300.00	—	389.00	—	—	—	—	—	—	—	—	—	—	—	\$3 86	2.54
Nov. 20 to Dec. 11.	177.00	8.05	71.50	71.50	71.50	—	—	—	—	240.00	—	—	—	—	—	—	—	—	—	3 33	1.88
Dec. 17 to Dec. 27.	92.75	8.43	35.75	35.75	35.75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1 78	1.92
Jan. 3 to Jan. 21.	181.00	9.53	61.75	61.75	61.75	190.00	—	—	—	—	—	—	—	—	—	—	—	—	—	6 08	3.36
Jan. 29 to Feb. 19.	200.75	9.13	71.50	71.50	71.50	110.00	—	—	—	—	—	—	—	—	—	—	—	—	—	4 36	2.17
March 19 to April 2.	144.63	9.64	48.75	48.75	48.75	110.00	—	—	—	—	—	—	—	—	—	—	—	—	—	4 36	3.01
April 9 to April 22.	130.13	9.29	45.50	45.50	45.50	237.00	—	—	—	—	—	—	—	—	—	—	—	—	—	3 28	2.52
April 30 to May 21.	220.25	10.01	71.50	71.50	71.50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5 34	2.42

## TOTAL COST OF FEED PER QUART OF MILK — Continued.

*Eva.*

FEEDING PERIODS.	Total Quantity of Milk produced.	Average Daily Yield of Milk.	Total Amount of Corn consumed.	Total Amount of Wheat consumed.	Total Amount of Gluten consumed.	Total Amount of Hay consumed.	Total Amount of Food consumed.	Total Amount of Corn consumed.	Total Amount of Carrots consumed.	Total Amount of Corn ensilage consumed.	Total Amount of Sugar beets consumed.	Total Amount of Hay consumed.	Total Cost of Feed consumed.	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk.
<b>1888 and 1889.</b>	<b>Qts.</b>	<b>Qts.</b>	<b>Lbs.</b>	<b>Lbs.</b>	<b>Lbs.</b>	<b>Lbs.</b>	<b>Lbs.</b>	<b>Lbs.</b>	<b>Lbs.</b>	<b>Lbs.</b>	<b>Lbs.</b>	<b>Lbs.</b>	<b>Lbs.</b>	<b>Cents.</b>	<b>Cents.</b>
Nov. 1 to Nov. 15, .	224 25	14.95	48.75	48.75	48.75	300.00	—	—	—	—	—	—	\$3 86	1.72	
Nov. 20 to Dec. 11, .	258 75	11.76	71.50	71.50	71.50	—	401.00	—	—	—	—	—	3 36	1.30	
Dec. 17 to Dec. 27, .	119 25	10.84	35.75	35.75	35.75	—	—	209.00	—	—	—	—	1 70	1.43	
Jan. 3 to Jan. 21, .	230 50	12.13	61.75	61.75	61.75	190.00	—	—	748.00	—	—	—	6 08	2.64	
Jan. 29 to Feb. 19, .	254 75	11.58	71.50	71.50	71.50	110.00	—	—	—	946.00	—	—	4 49	1.76	
March 1 to March 14, .	150 25	10.73	45.50	45.50	45.50	286.00	—	—	—	—	—	—	3 65	2.43	
March 19 to April 2, .	164 88	10.99	48.75	48.75	48.75	150.00	—	—	—	—	693.00	—	4 47	2.71	

*Melia.*

Nov. 1 to Nov. 15, .	144 00	9.60	48.75	48.75	48.75	281.00	—	—	—	—	—	—	\$3 76	2.58	
Nov. 20 to Dec. 11, .	157 75	7.17	71.50	71.50	71.50	—	296.00	—	—	—	—	—	3 10	1.97	
Dec. 17 to Dec. 27, .	71 25	6.48	35.75	35.75	35.75	—	—	189.00	—	—	—	—	1 65	2.32	
Jan. 3 to Jan. 21, .	145.50	7.66	61.75	61.75	61.75	190.00	—	—	748.00	—	—	—	6 08	4.18	
Jan. 29 to Feb. 19, .	158.50	7.20	71.50	71.50	71.50	110.00	—	—	—	755.00	—	—	4 22	2.66	

TOTAL COST OF FEED PER QUART OF MILK — *Continued.**Daisy.*

FEEDING PERIODS.	Total Quantity of Milk produced.	Average Daily Yield of Milk.	Total Amount consumed.										Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk.	
			Total Amount of Corn consumed.	Total Amount of Wheat consumed.	Total Amount of Gluten consumed.	Total Amount of Hay consumed.	Total Amount of Clover consumed.	Total Amount of Carrots consumed.	Total Amount of Corn consumed.	Total Amount of Sugar beets consumed.	Total Amount of Rowen consumed.				
1888 and 1889.															
Nov. 1 to Nov. 15, .	148.00	9.87	48.75	48.75	48.75	390.00	—	—	—	—	—	—	—	\$4.08	2.76
Nov. 20 to Dec. 11, .	139.75	6.35	71.50	71.50	71.50	—	431.00	—	—	—	—	—	—	3.44	2.46
Dec. 17 to Dec. 27, .	59.75	5.43	35.75	35.75	35.75	—	—	290.00	—	—	—	—	—	1.90	3.18
Jan. 3 to Jan. 18, .	97.50	6.09	52.00	52.00	52.00	160.00	—	—	692.00	—	—	—	—	5.34	5.48

*Minnie.*

Nov. 1 to Nov. 15, .	117.50	7.83	48.75	48.75	48.75	48.75	262.75	—	—	—	—	—	—	\$3.58	3.05
Nov. 20 to Dec. 11, .	135.25	6.15	71.50	71.50	71.50	71.50	—	257.00	—	—	—	—	—	3.00	2.22

## TOTAL COST OF FEED PER QUART OF MILK — Continued.

*Flora.*

FEEDING PERIODS.	Total Quantity of Milk produced.	Average Daily Yield of Milk.	Total Amount of Corn consumed.	Total Amount of Wheat consumed.	Total Amount of Oaten Meal consumed.	Total Amount of Hay consumed.	Total Amount of Fodder consumed.	Total Amount of Corn Stover consumed.	Total Amount of Carrots consumed.	Total Amount of Corn Mealage consumed.	Total Amount of Sugar beets consumed.	Total Amount of Rowen consumed.	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk.
<b>1898 and 1899.</b>	Qts.	Qts.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	\$	Cents.
Jan. 3 to Jan. 21, .	290.75	15.30	61.75	61.75	61.75	190.00	—	—	742.00	—	—	—	\$6 06	2 08
Jan. 29 to Feb. 19, .	292.75	13.31	71.50	71.50	71.50	110.00	—	—	—	680.00	—	—	4 12	1 41
March 1 to March 14, .	168.63	12.05	45.50	45.50	45.50	208.00	—	—	—	—	—	—	3 06	1 81
March 19 to April 2, .	196.50	13.10	48.75	48.75	48.75	150.00	—	—	—	—	653.00	—	4 37	2 22
April 9 to April 22, .	182.25	13.02	45.50	45.50	45.50	255.00	—	—	—	—	—	—	3 41	1 87
April 30 to May 21, .	294.13	13.37	71.50	71.50	71.50	—	—	—	—	—	—	423.00	5 53	1 88

*Jessie.*

FEEDING PERIODS.	Total Quantity of Milk produced.	Average Daily Yield of Milk.	Total Amount of Corn consumed.	Total Amount of Wheat consumed.	Total Amount of Oaten Meal consumed.	Total Amount of Hay consumed.	Total Amount of Fodder consumed.	Total Amount of Corn Stover consumed.	Total Amount of Carrots consumed.	Total Amount of Corn Mealage consumed.	Total Amount of Sugar beets consumed.	Total Amount of Rowen consumed.	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk.
<b>1898 and 1899.</b>	Qts.	Qts.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	\$	Cents.
Jan. 29 to Feb. 19, .	310.75	14.12	71.50	71.50	71.50	110.00	—	—	—	926 00	—	—	\$4 46	1 43
March 1 to March 14, .	160.50	11.46	45.50	45.50	45.50	213.00	—	—	—	—	—	—	3 10	1 93
March 19 to April 2, .	176.00	11.73	48.75	48.75	48.75	150.00	—	—	—	—	712.00	—	4 51	2 56
April 9 to April 22, .	178.88	12.78	45.50	45.50	45.50	265.00	—	—	—	—	—	—	3 49	1 95
April 30 to May 21, .	291.12	13.23	71.50	71.50	71.50	—	—	—	—	—	—	446.00	5 70	1 96



## TOTAL COST OF FEED PER QUART OF MILK—Concluded.

*Elsie.*

FEEDING PERIODS.	Total Quantity of Milk produced.		Average Daily Yield of Milk.		Total Amount of Corn Meal consumed.		Total Amount of Wheat Bran consumed.		Total Amount of Gluten Meal consumed.		Total Amount of Hay consumed.		Total Amount of Fod-der Corn consumed.		Total Amount of Corn Stover consumed.		Total Amount of Car-rots consumed.		Total Ensilage consumed.		Total Amount of Sugar Beets consumed.		Total Amount of Rowen consumed.		Total Cost of Feed con-sumed.		Average Cost of Feed for Production of One Quart of Milk.	
	Qts.		Qts.		Lbs.		Lbs.		Lbs.		Lbs.		Lbs.		Lbs.		Lbs.		Lbs.		Lbs.		Lbs.		\$		Cents.	
1888 and 1889.																												
March 19 to April 2, .	204.63	.	13.64		48.75		48.75		48.75		150.00		—		—		—		—		744.00		—		\$4.59		2.24	
April 9 to April 22, .	171.50	.	12.25		45.50		45.50		45.50		298.50		—		—		—		—		—		516.00		3.74		2.18	
April 30 to May 21, .	272.25	.	12.33		71.50		71.50		71.50		—		—		—		—		—		—		—		6.23		2.29	

# 26 AGRICULTURAL EXPERIMENT STATION. [Jan.

## *Valuation of Essential Fertilizing Constituents contained in the Various Articles of Fodder used.*

Nitrogen, 17 cents per pound; phosphoric acid, 6 cents; potassium oxide,  $4\frac{1}{2}$  cents. (1889.)

[Per cent.]

	Corn Meal.	Wheat Bran.	Gluten Meal.	Hay.	Fodder Corn.	Corn Stover.	Carrots.	Corn Ensilage.	Sugar Beets.	Rowen.
Moisture, . . .	12.890	10.080	10.220	8.060	36.850	50.130	90.050	74.760	87.210	10.950
Nitrogen, . . .	1.550	2.556	4.330	1.480	.992	.638	.127	.331	.208	2.030
Phosphoric acid,	.713	2.900	.392	.112	.367	.133	.100	.138	.086	.351
Potassium oxide,	.430	1.637	.049	.457	.801	.976	.070	.301	.462	2.794
Valuation per 2,000 pounds,	\$6 51	\$13 64	\$15 23	\$5 58	\$4 53	\$3 21	\$0 62	\$1 56	\$1 23	\$9 83

## NET COST OF MILK AND MANURIAL VALUE OF FEED.

### *Annie.*

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting the Twenty Per cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
<b>1888 and 1889.</b>					Cents.	Lbs.
Nov. 1 to Nov. 15, .	\$3 71	\$1 64	\$1 31	\$2 40	1.50	825
Nov. 20 to Dec. 11, .	3 11	1 95	1 56	1 55	0.83	790
Dec. 17 to Dec. 27, .	1 58	89	71	87	1.12	772
Jan. 3 to Jan. 21, .	5 93	1 84	1 47	4 46	2.28	812
Jan. 29 to Feb. 19, .	4 09	2 09	1 67	2 42	1.09	812
Mar. 1 to Mar. 14, .	3 08	1 39	1 11	1 97	1.55	845
Mar. 19 to Apr. 2, .	4 37	1 68	1 34	3 03	1.96	859
Apr. 9 to Apr. 22, .	3 23	1 45	1 16	2 07	1.45	895
Apr. 30 to May 21, .	5 10	3 07	2 46	2 64	1.15	890
Total, . . .	\$34 20	\$16 00	\$12 79	\$21 41	-	-

NET COST OF MILK AND MANURIAL VALUE OF FEED — *Continued.**May.*

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting the Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
<b>1888 and 1889.</b>					<b>Cents.</b>	<b>Lbs.</b>
Nov. 1 to Nov. 15, .	\$3 86	\$1 70	\$1 36	\$2 50	1.64	950
Nov. 20 to Dec. 11, .	3 33	2 14	1 71	1 62	.92	900
Dec. 17 to Dec. 27, .	1 78	1 02	81	97	1.05	907
Jan. 3 to Jan. 21, .	6 08	1 86	1 49	4 59	2.54	911
Jan. 29 to Feb. 19, .	4 36	2 24	1 79	2 57	1.28	940
Mar. 19 to Apr. 2, .	4 36	1 68	1 34	3 02	2.09	935
Apr. 9 to Apr. 22, .	3 28	1 47	1 18	2 10	1.61	990
Apr. 30 to May 21, .	5 34	3 22	2 58	2 76	1.25	935
Total, . .	\$32 39	\$15 33	\$12 26	\$20 13	—	—

*Eva.*

Nov. 1 to Nov. 15, .	\$3 86	\$1 70	\$1 36	\$2 50	1.11	1,020
Nov. 20 to Dec. 11, .	3 36	2 17	1 74	1 62	.63	958
Dec. 17 to Dec. 27, .	1 70	97	78	92	.77	940
Jan. 3 to Jan. 21, .	6 08	1 86	1 49	4 59	1.99	970
Jan. 29 to Feb. 19, .	4 49	2 31	1 85	2 64	1.04	978
Mar. 1 to Mar. 11, .	3 65	1 60	1 28	2 37	1.58	1,030
Mar. 19 to Apr. 2, .	4 47	1 70	1 36	3 11	1.89	1,000
Total, . .	\$27 61	\$12 31	\$9 86	\$17 75	—	—

*Melia.*

Nov. 1 to Nov. 15, .	\$3 72	\$1 65	\$1 32	\$2 40	1.67	1,075
Nov. 20 to Dec. 11, .	3 10	1 93	1 54	1 56	.99	1,036
Dec. 17 to Dec. 27, .	1 65	94	75	90	1.26	1,025
Jan. 3 to Jan. 21, .	6 08	1 86	1 49	4 59	3.15	1,075
Jan. 29 to Feb. 19, .	4 22	2 16	1 73	2 49	1.57	1,096
Total, . .	\$18 77	\$8 54	\$6 83	\$11 94	—	—

*Daisy.*

Nov. 1 to Nov. 15, .	\$4 08	\$1 78	\$1 42	\$2 66	1.80	1,170
Nov. 20 to Dec. 11, .	3 44	2 24	1 79	1 65	1.18	1,165
Dec. 17 to Dec. 27, .	1 90	1 10	88	1 02	1.71	1,176
Jan. 3 to Jan. 18, .	5 34	1 58	1 26	4 18	4.29	1,220
Total, . .	\$14 76	\$6 70	\$5 35	\$9 41	—	—

# 28 AGRICULTURAL EXPERIMENT STATION. [Jan.

## NET COST OF MILK AND MANURIAL VALUE OF FEED — *Concluded.*

### *Minnie.*

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting the Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at close of Period.
<b>1888 and 1889.</b>					Cents.	Lbs.
Nov. 1 to Nov. 15, .	\$3 58	\$1 60	\$1 28	\$2 30	1.96	1,050
Nov. 20 to Dec. 11, .	3 00	1 85	1 48	1 52	1.12	1,017
Total, . . .	\$6 58	\$3 45	\$2 76	\$3 82	—	—

### *Flora.*

Jan. 3 to Jan. 21, .	\$6 06	\$1 85	\$1 48	\$4 58	1.58	882
Jan. 29 to Feb. 19, .	4 12	2 10	1 68	2 44	.83	859
Mar. 1 to Mar. 14, .	3 06	1 39	1 11	1 95	1.16	870
Mar. 19 to Apr. 2, .	4 37	1 68	1 34	3 03	1.54	875
Apr. 9 to Apr. 22, .	3 41	1 52	1 22	2 19	1.20	927
Apr. 30 to May 21, .	5 53	3 34	2 67	2 86	.97	918
Total, . . .	\$26 55	\$11 88	\$9 50	\$17 05	—	—

### *Jessie.*

Jan. 29 to Feb. 19, .	\$4 46	\$2 29	\$1 83	\$2 63	0.85	736
Mar. 1 to Mar. 14, .	3 10	1 40	1 12	1 98	1.23	730
Mar. 19 to Apr. 2, .	4 51	1 72	1 38	3 13	1.78	751
Apr. 9 to Apr. 22, .	3 49	1 54	1 23	2 26	1.26	806
Apr. 30 to May 21, .	5 70	3 47	2 78	2 92	1.00	809
Total, . . .	\$21 26	\$10 42	\$8 34	\$12 92	—	—

### *Elsie.*

Mar. 19 to Apr. 2, .	\$4 59	\$1 74	\$1 39	\$3 20	1.56	1,105
Apr. 9 to Apr. 22, .	3 74	1 64	1 31	2 43	1.42	1,120
Apr. 30 to May 21, .	6 23	3 80	3 04	3 19	1.17	1,120
Total, . . .	\$14 56	\$7 18	\$5 74	\$8 82	—	—

## ANALYSES OF MILK.

[Per cent.]

*Annie.*

1888 and 1889.	Nov. 14.	Dec. 4.	Dec. 24.	Jan. 16.	Feb. 11.	Mar. 11.	Apr. 2.	Apr. 16.	May 7.
Solids, . . .	13.68	15.22	14.83	14.10	14.30	14.25	14.52	14.06	14.18
Fat, . . .	3.65	5.10	4.90	4.10	4.55	4.61	4.72	4.60	4.67
Solids not fat, .	10.03	10.12	9.93	10.00	9.75	9.64	9.80	9.46	9.51

*May.*

Solids, . . .	14.90	14.42	15.37	15.42	15.05	—	15.02	15.24	14.61
Fat, . . .	4.13	5.30	4.74	4.60	4.65	—	4.60	5.20	4.87
Solids not fat, .	10.77	9.12	10.63	10.82	10.40	—	10.42	10.04	9.74

*Eva.*

Solids, . . .	14.40	14.45	15.11	14.90	14.95	15.52	15.63	—	—
Fat, . . .	4.85	5.25	5.17	4.82	4.95	5.51	5.33	—	—
Solids not fat, .	9.55	9.20	9.94	10.08	10.00	10.01	10.30	—	—

*Melia.*

Solids, . . .	13.82	13.87	14.40	13.86	13.30	—	—	—	—
Fat, . . .	3.70	4.38	4.34	3.50	3.80	—	—	—	—
Solids not fat, .	10.12	9.49	10.06	10.36	9.50	—	—	—	—

*Daisy.*

Solids, . . .	15.48	14.18	16.70	15.73	—	—	—	—	—
Fat, . . .	4.44	4.48	4.93	3.24	—	—	—	—	—
Solids not fat, .	11.04	9.70	11.77	12.49	—	—	—	—	—

*Minnie.*

Solids, . . .	14.22	14.07	—	—	—	—	—	—	—
Fat, . . .	4.49	4.85	—	—	—	—	—	—	—
Solids not fat, .	9.73	9.22	—	—	—	—	—	—	—

# 30 AGRICULTURAL EXPERIMENT STATION. [Jan.

## ANALYSES OF MILK—*Concluded.*

### *Flora.*

1888 and 1889.	Nov. 14.	Dec. 4.	Dec. 24.	Jan. 16.	Feb. 11.	Mar. 11.	Apr. 2.	Apr. 16.	May 7.
Solids, . . .	-	-	-	12.90	12.77	13.15	13.17	12.57	12.77
Fat, . . .	-	-	-	3.15	3.55	3.68	3.73	3.40	3.46
Solids not fat, .	-	-	-	9.75	9.22	9.47	9.44	9.17	9.31

### *Jessie.*

Solids, . . .	-	-	-	-	13.22	13.75	15.12	14.91	15.00
Fat, . . .	-	-	-	-	4.25	4.57	5.34	5.45	4.67
Solids not fat, .	-	-	-	-	8.97	9.18	9.78	9.46	10.33

### *Elsie.*

Solids, . . .	-	-	-	-	-	-	12.20	12.75	12.65
Fat, . . .	-	-	-	-	-	-	3.14	3.09	3.38
Solids not fat, .	-	-	-	-	-	-	9.06	9.66	9.27

ANALYSES OF FODDER ARTICLES FED DURING THE PREVIOUSLY  
DESCRIBED FEEDING EXPERIMENTS. (NOVEMBER, 1888, TO  
MAY, 1889.)

*Corn Meal (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	12.89	257.80	—	—	1:9.01
Dry matter, . . . . .	87.11	1,742.20	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.36	27.20	—	—	
“ cellulose, . . . . .	1.90	38.00	12.92	34	
“ fat, . . . . .	4.16	83.20	63.23	76	
“ protein (nitrogenous matter), . . . . .	11.12	222.40	189.04	85	
Non-nitrogenous extract matter, . . . . .	81.46	1,629.20	1,531.45	94	
	100.00	2,000.00	1,796.64	—	

*Wheat Bran (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	10.08	201.60	—	—	1:3.80
Dry matter, . . . . .	89.92	1,798.40	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.38	127.60	—	—	
“ cellulose, . . . . .	10.74	214.80	42.96	20	
“ fat, . . . . .	4.34	86.80	69.44	80	
“ protein (nitrogenous matter), . . . . .	17.77	355.40	312.75	88	
Non-nitrogenous extract matter, . . . . .	60.77	1,215.40	972.32	80	
	100.00	2,000.00	1,397.47	—	



ANALYSES OF FODDER ARTICLES FED, ETC. — *Continued.**Gluten Meal (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	10.22	204.40	-	-	} 1 : 2.74
Dry matter, . . . . .	89.78	1,795.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	.52	10.40	-	-	
“ cellulose, . . . . .	.56	11.20	3.81	94	
“ fat, . . . . .	5.50	110.00	83.60	76	
“ protein (nitrogenous matter), . . . . .	90.15	603.00	512.55	85	
Non-nitrogenous extract matter, . . . . .	63.27	1,265.40	1,189.48	94	
	100.00	2,000.00	1,789.44	-	

*Hay.*

[Experiment Station, 1888.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	8.06	161.20	-	-	} 1 : 9.05
Dry matter, . . . . .	91.94	1,838.80	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.67	133.40	-	-	
“ cellulose, . . . . .	33.75	675.00	391.50	58	
“ fat, . . . . .	2.09	41.80	19.23	46	
“ protein (nitrogenous matter), . . . . .	10.06	201.20	114.68	57	
Non-nitrogenous extract matter, . . . . .	47.43	948.60	597.62	63	
	100.00	2,000.00	1,123.03	-	

ANALYSES OF FODDER ARTICLES FED, ETC. — *Continued.**Corn Fodder.*

[Experiment Station, 1888.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	36.85	737.00	-	-	1 : 8.46
Dry matter, . . . . .	63.15	1,263.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	4.84	96.80	-	-	
" cellulose, . . . . .	21.96	439.20	316.22	72	
" fat, . . . . .	2.02	40.40	30.30	75	
" protein (nitrogenous matter), . . . . .	9.82	196.40	143.37	73	
Non-nitrogenous extract matter, . . . . .	61.36	1,227.20	822.22	67	
	100.00	2,000.00	1,312.11	-	

*Corn Stover.*

[Experiment Station, 1888.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	50.13	1,002.60	-	-	1 : 10.78
Dry matter, . . . . .	49.87	997.40	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	3.73	74.60	-	-	
" cellulose, . . . . .	34.49	689.80	496.66	72	
" fat, . . . . .	1.75	35.00	26.25	75	
" protein (nitrogenous matter), . . . . .	8.00	160.00	116.80	73	
Non-nitrogenous extract matter, . . . . .	52.03	1,040.60	697.20	67	
	100.00	2,000.00	1,336.91	-	

# 34 AGRICULTURAL EXPERIMENT STATION. [Jan.

## ANALYSES OF FODDER ARTICLES FED, ETC. — *Continued.*

### *Carrots (Danvers).*

[Experiment Station, 1888.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	90.05	1,801.00	—	—	} 1:9.17
Dry matter, . . . . .	9.95	199.00	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	8.28	165.60	—	—	
“ cellulose, . . . . .	10.26	205.20	205.20	100	
“ fat, . . . . .	1.67	33.40	33.40	100	
“ protein (nitrogenous matter), . . . . .	7.98	159.60	159.60	100	
Non-nitrogenous extract matter, . . . . .	71.81	1,436.20	1,436.20	100	
	100.00	2,000.00	1,834.40	—	

### *Corn Ensilage.*

[Experiment Station, 1888.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	74.56	1,491.20	—	—	} 1:11.72
Dry matter, . . . . .	25.44	508.80	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.07	21.40	—	—	
“ cellulose, . . . . .	20.11	402.20	289.58	72	
“ fat, . . . . .	6.49	129.80	97.35	75	
“ protein (nitrogenous matter), . . . . .	8.14	162.80	118.84	73	
Non-nitrogenous extract matter, . . . . .	64.19	1,283.80	860.15	67	
	100.00	2,000.00	1,365.92	—	

ANALYSES OF FODDER ARTICLES FED, ETC.—*Continued.**Sugar Beets (Average).*

[Experiment Station, 1888.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.	
Moisture at 100° C., . . . .	87.21	1,744.20	—	—	} 1 : 8.36	
Dry matter, . . . . .	12.79	255.80	—	—		
	100.00	2,000.00	—	—		
<i>Analysis of Dry Matter.</i>						
Crude ash, . . . . .	6.47	129.40	—	—		
“ cellulose, . . . . .	6.16	123.20	123.20	100		
“ fat, . . . . .	.98	19.60	19.60	100		
“ protein (nitrogenous matter), . . . . .	10.15	203.00	203.00	100		
Non-nitrogenous extract matter, . . . . .	76.24	1,524.80	1,524.80	100		
	100.00	2,000.00	1,870.60	—		

*Rowen.*

[Experiment Station, 1888.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	10.95	219.00	-	-	} 1 : 6.28
Dry matter, . . . . .	89.05	1,781.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.49	129.80	-	-	
" cellulose, . . . . .	31.50	630.00	365.40	58	
" fat, . . . . .	5.03	100.60	46.28	46	
" protein (nitrogenous matter), . . . . .	14.25	285.00	162.45	57	
Non-nitrogenous extract matter, . . . . .	42.73	854.60	538.40	63	
	100.00	2,000.00	1,110.53	-	

# 36 AGRICULTURAL EXPERIMENT STATION. [Jan.

## ANALYSES OF FODDER ARTICLES FED, ETC. — *Concluded.*

### *Corn Fodder.*

[Mostly stalks; left uneaten by the cows during experiment.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	53.70	1,074.00	—	—	} 1 : 13.92
Dry matter, . . . . .	46.30	926.00	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	3.44	68.80	—	—	
“ cellulose, . . . . .	39.31	786.20	566.06	72	
“ fat, . . . . .	2.83	56.60	42.45	75	
“ protein (nitrogenous matter), . . . . .	6.47	129.40	94.46	73	
Non-nitrogenous extract matter, . . . . .	47.95	959.00	642.53	67	
	100.00	2,000.00	1,345.50	—	

### *Corn Stover.*

[Mostly stalks; left uneaten by the cows during experiment.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	62.85	1,257.00	—	—	} 1 : 16.30
Dry matter, . . . . .	37.15	743.00	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	2.36	47.20	—	—	
“ cellulose, . . . . .	37.52	750.40	540.29	72	
“ fat, . . . . .	3.50	70.00	52.50	75	
“ protein (nitrogenous matter), . . . . .	5.94	118.80	86.72	73	
Non-nitrogenous extract matter, . . . . .	50.68	1,013.60	679.11	67	
	100.00	2,000.00	1,358.62	—	

SUMMARY OF FEEDING EXPERIMENTS WITH MILCH COWS.  
(NOVEMBER, 1885, TO MAY, 1889.)

*Fodder Corn, Corn Stover and Corn Ensilage vs. English Hay.*

In preceding communications it will be found that some years ago, November, 1885, a series of observations with milch cows was inaugurated at our institution, for the purpose of securing, under well-defined circumstances, information needed to assist in answering the following questions:—

1. What is the comparative feeding effect of dry fodder corn, of dry corn stover, and of a good corn ensilage, when used in part or in the whole as a substitute for English hay (upland meadow hay) in the daily diet of milch cows, and also that of a good root crop in place of corn ensilage; the amount and kind of grain feed remaining, for obvious reasons, the same under otherwise corresponding circumstances?

2. What is the *total cost*, as well as the *net cost* of the *daily feed* per head in case of different fodder combinations used; making in all cases alike an allowance of a loss of twenty per cent. of the fertilizing constituents contained in the feed consumed, in consequence of the sale of the milk?

3. What is the commercial value, at current market rates, of the manurial refuse obtainable in the case of different fodder combinations used as daily diet for the support of cows, assuming that eighty per cent. of the value of the fertilizing constituents contained in the fodder consumed can be secured to the farm by a careful management?

The results of experiments carried on in this connection during a number of months of the years 1885, 1886, 1887 and 1888, have already been described in detail in our respective annual reports and periodical bulletins. More recent observations in the same direction are reported upon some preceding pages.

As a careful consideration of all our results to date leads practically to the same conclusions, the subsequent final summary of our work has been prepared with a view of enabling, as far as practicable, all parties interested in our special line of inquiry into the economy of milk production to draw their own conclusions, and to ascertain for themselves whether the stand-point taken in our several reports, of progress, is justifiable by the facts presented.

## RECORD OF FEEDING EXPERIMENTS.

November, 1885, to May, 1889.\*

Period of Observation.	Fodder Articles consumed, and Their Cost per Ton.	Nutritive Character of Feed (Nutritive Ratio).	Names of Cows on Trial.	Variations in the Daily Yield of Milk (Quarts).	Average Production of Milk per Day during the Entire Period (Quarts).	Variations in the Total Cost of Feed per Quart of Milk produced (Cents).	Variations in the Net Cost of Feed per Quart of Milk produced (Cents).	Variations in the Amount of Dry Matter in the Feed consumed per Quart of Milk (Pounds).
Nov. 20, 1885, to July 4, 1886.	Corn meal, . . . \$23 00	1:6.7 to 1:10.17 Mean, 1: 7.86	1. Daisy (1) 2. Mollie	16.3 - 8.4 12.62- 8.60	12.77 11.00	.97-2.64 1.02-2.50	.50-1.64 .51-1.61	1.44-2.86 1.56-2.80
	Wheat bran, . . . 20 00							
	English hay, . . . 15 00							
	Corn stover, . . . 5 00							
	Corn ensilage, . . . 2 75							
Oct. 1, 1886, to April 24, 1887.	Sugar beets, . . . 5 00	1:5.99 to 1:7.90 Mean, 1:6.60	1. Susie 2. Meg 3. Dora	13.5 - 9.4 13.9 -10.3 16.3 -11.7	11.92 11.93 13.94	1.04-2.37 .96-2.76 .85-2.26	.43-1.67 .41-1.96 .34-1.60	1.66-2.76 1.72-2.43 1.58-2.23
	Corn meal, . . . \$23 00							
	Wheat bran, . . . 20 00							
	Gluten meal, . . . 23 00							
	Rye middlings, . . . 24 00							
	English hay, . . . 15 00							
	Corn stover, . . . 5 00							
	Corn ensilage, . . . 2 75							
	Carrots, . . . 7 00							

\* For more details, consult the respective annual reports on the work of this station.

RECORD OF FEEDING EXPERIMENTS.  
November, 1885, to May, 1889.\*

Period of Observation.	Fodder Articles consumed, and Their Cost per Ton.	Nutritive Character of Feed (Nutritive Ratio).	Names of Cows on Trial.	Variations in the Daily Yield of Milk (Quarts).	Average Production of Milk per Day during the Entire Period (Quarts).	Variations in the Total Cost of Feed per Quart of Milk produced (Cents).	Variations in the Cost of Feed per Quart of Milk produced (Cents).	Variations in the Amount of Dry Matter in the Feed consumed per Quart of Milk (Pounds).
Jan. 8, 1888, to May 15, 1888.	Corn meal, . . . \$23 00	1: 5.20 to 1: 6.10 Mean, 1: 5.80	1. May (1)	12.3-10.1	11.23	1.51-2.51	.77-1.63	1.94-2.50
	Wheat bran, . . . 20 70		2. Minnie (1)	12.7-10.2	11.49	1.40-2.53	.74-1.65	1.73-2.52
	Gluten meal, . . . 27 00		3. Melia (1)	14.6-10.9	12.62	1.28-2.44	.66-1.59	1.73-2.43
	Corn and cob meal, . . . 20 70		4. Eva (1)	7.2- 5.5	6.22	2.58-4.74	1.39-3.09	3.36-4.74
	English hay, . . . 15 00		5. Lizzie (2)	10.6- 7.9	9.06	1.68-3.36	.95-2.19	2.17-3.35
	Corn stover, . . . 5 00		6. Daisy (2)	19.2-13.5	16.22	1.01-1.97	.50-1.28	1.38-1.96
	Corn ensilage, . . . 2 75							
Nov. 1, 1888, to May 21, 1889.	Fodder corn, . . . 5 00	1: 5.13 to 1: 6.79 Mean, 1: 6.02						
	Corn meal, . . . \$21 90		1. Annie (2)	10.68- 7.09	9.65	1.66-3.04	.83-2.28	2.00-2.48
	Wheat bran, . . . 20 70		2. May (2)	10.13- 8.06	9.21	1.88-3.36	.92-2.54	2.29-2.67
	Gluten meal, . . . 23 40		3. Eva (2)	14.95-10.73	11.79	1.30-2.72	.63-1.99	1.67-2.49
	English hay, . . . 15 00		4. Daisy (3)	9.87- 5.43	6.95	2.46-5.48	1.18-4.29	2.93-4.04
	Fodder corn, . . . 5 00		5. Jessie (2)	14.12-11.46	12.84	1.43-2.56	.85-1.78	1.70-2.04
	Corn stover, . . . 5 00		6. Melia (2)	9.60- 7.17	7.05	1.97-4.18	.99-3.15	2.39-3.05
	Corn ensilage, . . . 2 75		7. Elsie (2)	13.64-12.25	12.71	2.18-2.29	1.17-1.56	1.78-2.39
	Carrots, . . . 7 00		8. Minnie (2)	7.83- 6.15	6.83	2.22-3.05	1.12-1.96	2.61-3.16
	Sugar beets, . . . 5 00		9. Flora	15.30-12.06	13.82	1.41-2.22	.83-1.58	1.42-1.95
	Rowen, . . . 15 00							

\* For more details, consult the respective annual reports on the work of this station.



## 40 AGRICULTURAL EXPERIMENT STATION. [Jan.

A short discussion of the most important facts presented in the preceding tabular statement may assist in a desirable appreciation of the questions involved.

During our first year of observation, November, 1885, to July, 1886, either corn meal and wheat bran or wheat bran alone served as grain feed; while, during the succeeding years, as a rule, the same weight parts of corn meal, wheat bran and gluten meal were fed.

The above-stated variations of daily yield of milk refer to the highest and lowest yield in each case, and do not bear a direct relation to any particular diet.

The valuation of the fodder ingredients is based in this connection on the average of the local market price per ton of each article for the entire period of observation.

Corn meal, . . . . \$22 75	Fodder corn, . . . . \$5 00
Wheat bran, .. . . 21 00	Corn stover, . . . . 5 00
Gluten meal, . . . . 24 50	Corn ensilage, . . . . 2 75
Hay, . . . . 15 00	Carrots, . . . . 7 00
Rowen, . . . . 15 00	Sugar beets, . . . . 5 00

The commercial valuation of the fertilizing constituents contained in each fodder article is based on the following market prices: *i. e.*, nitrogen (per pound), 17 cents; phosphoric acid, 6 cents; and potassium oxide, 4½ cents. Eighty per cent. of the entire amount of fertilizing constituents contained in the fodder consumed is considered obtainable by proper management, while twenty per cent. is assumed to be sold with the milk.

### PRINCIPAL DAILY FODDER RATIONS USED.

*November, 1885, to July, 1886.*

1.	2.
Corn meal, . . . . 3.25 lbs.	Corn meal, . . . . 3.25 lbs.
Wheat bran, . . . . 3.25 "	Wheat bran, . . . . 3.25 "
Hay, . . . . 21.75 "	Hay, . . . . 10.00 "
Total cost, . . . . 23.43 cts.	Corn stover, . . . . 8.00 "
Net cost, . . . . 15.43 "	Total cost, . . . . 16.62 cts.
Manurial value obtain- able, . . . . 8.00 "	Net cost, . . . . 10.04 "
Nutritive ratio, . . . 1 : 8.02	Manurial value obtain- able, . . . . 6.58 "
	Nutritive ratio, . . . 1 : 7.88

PRINCIPAL DAILY FODDER RATIONS USED — *Continued.*

3.	4.
Corn meal, . . . 3.25 lbs.	Corn meal, . . . 3.25 lbs.
Wheat bran, . . . 3.25 "	Wheat bran, . . . 3.25 "
Hay, . . . 5 00 "	Hay, . . . 15.00 "
Corn stover, . . . 12.75 "	Sugar beets, . . . 27.00 "
Total cost, . . . 14.06 cts.	Total cost, . . . 25.12 cts.
Net cost, . . . 7.83 "	Net cost, . . . 17.10 "
Manurial value obtain-	Manurial value obtain-
able, . . . 6 23 "	able, . . . 8.02 "
Nutritive ratio, . . . 1 : 7.81	Nutritive ratio, . . . 1 : 7.20

5.	6.
Wheat bran, . . . 3.25 lbs.	Wheat bran, . . . 3.25 lbs.
Hay, . . . 15.00 "	Hay, . . . 15.00 "
Sugar beets, . . . 27.00 "	Sugar beets, . . . 40.00 "
Total cost, . . . 21.41 cts.	Total cost, . . . 24.66 cts.
Net cost, . . . 14.31 "	Net cost, . . . 16.66 "
Manurial value obtain-	Manurial value obtain-
able, . . . 7.10 "	able, . . . 8.00 "
Nutritive ratio, . . . 1 : 6.93	Nutritive ratio, . . . 1 : 6.81

*October, 1886, to April, 1887.*

7.	8.
Corn meal, . . . 3.25 lbs.	Corn meal, . . . 3.25 lbs.
Wheat bran, . . . 3.25 "	Wheat bran, . . . 3.25 "
Gluten meal, . . . 3.25 "	Gluten meal, . . . 3.25 "
Hay, . . . 18.75 "	Hay, . . . 5.00 "
Total cost, . . . 25.14 cts.	Corn ensilage, . . . 34.00 "
Net cost, . . . 15.77 "	Total cost, . . . 19 60 cts.
Manurial value obtain-	Net cost, . . . 11.62 "
able, . . . 9.37 "	Manurial value obtain-
Nutritive ratio, . . . 1 : 6.11	able, . . . 7.98 "
	Nutritive ratio, . . . 1 : 6.12

9.

Corn meal, . . . . . 3.25 lbs.
Wheat bran, . . . . . 3.25 "
Gluten meal, . . . . . 3.25 "
Hay, . . . . . 10.00 "
Carrots, . . . . . 38.00 "
Total cost, . . . . . 31.89 cts.
Net cost, . . . . . 23.05 "
Manurial value obtainable, . . . . . 8.84 "
Nutritive ratio, . . . . . 1 : 5.99

PRINCIPAL DAILY FODDER RATIONS USED — *Concluded.**January to May, 1888.*

10.				11.			
Corn meal, . . .	3.25	lbs.		Corn meal, . . .	3.25	lbs.	
Wheat bran, . . .	3.25	"		Wheat bran, . . .	3.25	"	
Gluten meal, . . .	3.25	"		Gluten meal, . . .	3.25	"	
Fodder corn, . . .	17.75	"		Corn stover, . . .	17.25	"	
Total cost, . . .	15.53	cts.		Total cost, . . .	15.40	cts.	
Net cost, . . .	7.54	"		Net cost, . . .	7.44	"	
Manurial value obtainable, . . .	7.99	"		Manurial value obtainable, . . .	7.96	"	
Nutritive ratio, . . .	1 : 5.82			Nutritive ratio, . . .	1 : 5.98		

12.

Corn meal, . . . . .	3.25	lbs.
Wheat bran, . . . . .	3.25	"
Gluten meal, . . . . .	3.25	"
Hay, . . . . .	10.00	"
Corn ensilage, . . . . .	21.75	"
Total cost, . . . . .	21.64	cts.
Net cost, . . . . .	13.15	"
Manurial value obtainable, . . . . .	8.49	"
Nutritive ratio, . . . . .	1 : 6.12	

*November, 1888, to May, 1889.*

13.				14.			
Corn meal, . . .	3.25	lbs.		Corn meal, . . .	3.25	lbs.	
Wheat bran, . . .	3.25	"		Wheat bran, . . .	3.25	"	
Gluten meal, . . .	3.25	"		Gluten meal, . . .	3.25	"	
Hay, . . . . .	10.00	"		Rowen, . . . . .	19.50	"	
Sugar beets, . . .	47.25	"		Total cost, . . .	25.72	cts.	
Total cost, . . .	30 40	cts.		Net cost, . . . .	13.51	"	
Net cost, . . . .	20.22	"		Manurial value obtainable, . . . .	12.21	"	
Manurial value obtainable, . . . .	10.18	"		Nutritive ratio, . . .	1 : 5.06		
Nutritive ratio, . . .	1 : 5.56						

Fodder rations Nos. 3, 8, 10, 11 and 14 deserve particular attention for trials. The remainder, although in some instances not without special interest, are published to illustrate our essential variations in the daily diet used.

TABULAR STATEMENT OF THE COST PER DAY OF THE ABOVE-MENTIONED FODDER COMBINATIONS.

						Total Cost.	Net Cost.	Manurial Value Obtainable.
						Cents.	Cents.	Cents.
No.	1.	.	.	.	.	23.43	15.43	8.00
"	2.	.	.	.	.	16.62	10.04	6.58
"	3.	.	.	.	.	14.06	7.83	6.23
"	4.	.	.	.	.	25.12	17.10	8.02
"	5.	.	.	.	.	21.41	14.31	7.10
"	6.	.	.	.	.	24.66	16.66	8.00
"	7.	.	.	.	.	25.14	15.77	9.37
"	8.	.	.	.	.	19.60	11.62	7.98
"	9.	.	.	.	.	31.89	23.05	8.84
"	10.	.	.	.	.	15.75	7.54	7.99
"	11.	.	.	.	.	15.40	7.44	7.96
"	12.	.	.	.	.	21.64	13 15	8.49
"	13.	.	.	.	.	30.40	20.22	10.18
"	14.	.	.	.	.	25.72	13.51	12.21

Considering the previously described fodder combinations from a mere financial stand-point, they rank, with reference to their net cost, beginning with the lowest, as follows: 11, 10, 3, 2, 8, 12, 14, 5, 1, 7, 6, 4, 13, 9. A close inquiry into the character of the coarser or bulky part of the various fodder compositions cannot fail to show that, wherever fodder corn, corn stover or corn ensilage have been fed in part or in the whole as a substitute for English hay, in connection with the same kind and amount of grain feed, the commercial value of the manurial refuse obtainable has been but slightly if any affected; while the net cost of the daily feed of the animals on trial has been materially reduced (from one-third to one-half). It seems scarcely necessary to mention, here, that only equally well-prepared fodder articles are considered in the discussion.

Sugar beets compare well, as far as net cost is concerned, with good corn ensilage, when fed in quantities of from twenty to twenty-five pounds of the former in place of from thirty to thirty-five pounds of the latter.

In view of these facts, it becomes a question of first importance to ascertain to what extent it will be judicious, as far as their commercial feed value is concerned, to advo-

cate the substitution of dry fodder corn, corn stover and a good corn ensilage for English hay in the daily diet of dairy stock.

It is generally admitted that the present condition of the market for dairy products calls for the closest investigation of every point which bears on the cost of the production of milk; and it will be not less conceded, that next in importance to the selection of cows of good milking qualities comes the consideration of the cost of their daily diet.

### *Net Cost of Feed.*

The actual cost of a daily diet for any kind of farm live stock does not alone depend on the temporary market cost of a given quantity of the various ingredients which constitute the daily fodder rations, but also in a controlling degree upon the quantity of some essential articles of plant food (in particular of nitrogen, phosphoric acid and potassium oxide) which they contain, and the amount of these which may be secured in some definite proportion in form of manurial refuse, after the fodder has served its purpose for the support of the life and the functions of the animal which consumes it. As has been already stated on previous occasions, the net cost of a daily diet is ascertained by deducting from the sum of the market price of its ingredients, the sum expressing the commercial value of their manurial constituents obtainable in each particular case. This circumstance deserves, for obvious reasons, the most serious consideration on the part of farmers, when choosing from among the various suitable fodder articles offered for their patronage, those for a daily diet of their farm live stock which will ultimately prove the cheapest in their position, in consequence of the higher commercial value of the manurial refuse they furnish.

It becomes the more important to select with that view in mind; as the fluctuations in the local market price of oil cakes, gluten meal, corn meal, wheat bran and of similar refuse materials (by-products) of flour mills, glucose works, starch works, breweries, etc., are, as a rule, liable to be more frequent and more serious than in case of home-raised coarse or bulky fodder articles, as English hay, corn stover,

corn ensilage, etc. The commercial value of the manurial refuse obtainable from the first-named class, in case of corresponding weights and under similar circumstances, exceeds quite frequently from two to three times that obtainable in case of the latter.

Applying this standard of valuation to our feeding experiments, we notice the following relations :—

*Fodder Articles used during our Feeding Experiments.*

Name of Article.	Market Price per Ton.	Value of Manu- rial Constituents per Ton.	Relative Net Cost per Ton.
English hay, . . . .	\$15 00	\$5 58	\$10 54
Rowen (dry), . . . .	15 00	9 83	7 14
Fodder corn (dry), . . . .	5 00	4 53	1 38
Corn stover (dry), . . . .	5 00	3 21	2 43
Corn ensilage, . . . .	2 75	1 56	1 50
Corn meal, . . . .	21 90	6 51	16 69
Wheat bran, . . . .	20 70	13 64	9 79
Gluten meal, . . . .	23 40	15 23	11 22

Considering our entire feeding experiments, 1885 to 1889, we find that corn meal has cost per ton \$22.75, wheat bran \$21, and gluten meal \$24.50. The latter sells to-day at \$23 per ton, corn meal at \$19, and wheat bran at \$16.50. The market price of hay, corn stover, etc., has practically remained the same, as far as the same season of the year is concerned. Serious variations in the market price of our fodder articles not infrequently advise changes from one article to another of a similar character and composition. At present local market prices of feed stuffs, hay and corn meal are very costly fodder articles; the same applies to carrots.

*Feeding Value or Nutritive Value of Fodder Articles.*

From preceding remarks it will be apparent that we have secured a satisfactory basis for our guidance to decide the relative money value of current fodder articles, as well as that of an entire diet. Quite different, however, is our situation, when the determination of their relative feeding

value is involved; for it is an undeniable fact that the relative commercial value of fodder articles does not necessarily coincide with their relative feeding value; it rarely does. This circumstance arises from the fact that both are determined by different standards. The *commercial* or *money value* of *fodder articles*, as far as they enter the general market, is regulated like that of other articles of merchandise, by supply and demand; the greater the former and the less the latter, the lower is the market price, etc.; the relative money value of a given quantity can be expressed for the same locality by one definite sum.

The *feeding value* or *nutritive value* of a *fodder article* refers especially to its feeding effect; it depends usually on the co-operation of a series of varying conditions, sometimes more or less beyond our control. Foremost among these are:—

1. A higher degree of adaptation with reference to particular kind and organization of the animal under consideration; its age and functions, etc.

2. The chemical composition and the general physical conditions, depending on stage of growth, mechanical preparation, etc., of the fodder ingredients to be used.

3. Whether the article constitutes the sole diet, or serves as a more or less prominent part of the daily diet. The feeding effect of most fodder articles is more or less modified by, and thus in a controlling degree dependent on, the character of the associated ingredients in the daily diet.

These few remarks suffice to show that the comparative feeding value of one and the same fodder article, even when of a stable composition, cannot be fully expressed by one numerical value. The practice of stating the comparative feeding value of current fodder articles with reference to that of good English hay equal to 100, has been for years abandoned, as devoid of any substantial support. There is no single fodder article on record which furnishes the best diet—i. e., the cheapest and at the same time most nutritive food—for even the same class of animals, under different circumstances. Both net cost of feed and its relative nutritive or feeding effect under existing circumstances, have to be consulted when aiming at an economical diet for farm

live stock. Actual feeding experiments, under well-defined circumstances, alone can give us the desired information.

Although much needs still to be done in this direction to recognize in many instances more clearly the principles which underlie a successful practice, it must be admitted that some valuable facts have been already established in regard to a rational and thus economical system of stock feeding, by European investigators and others, which can serve advantageously as guides in compounding economical fodder combinations for all kinds of farm live stock. The economy of milk production, in particular, has received much attention. European investigators recommend in this connection quite generally a daily diet, rich in digestible nitrogenous constituents, as beneficial to the general condition of cows, and at the same time reducing the net cost of the feed consumed, by furnishing larger quantities of valuable home-made manure at the lowest market cost. The European standard for a daily diet of milch cows calls for one part of digestible nitrogenous fodder constituents to five and four-tenths parts of digestible non-nitrogenous food constituents. Our results, on the whole, point in the same direction. The nitrogenous food constituents of the fodder rations received special attention.

The main interest of our inquiry, however, consists in the partial or entire successful substitution, under otherwise corresponding circumstances, of dry fodder corn or corn stover or corn ensilage for English hay, as far as net cost of feed and quality and quantity of milk are concerned. The results of former years of observation are already on record in our respective annual reports; they lead to the same conclusions as those stated in the introduction to our latest experiment, described in preceding pages. The net cost of the daily feed during our late experiment has been reported in that connection. The quality of the milk and cream obtained on that occasion may be learned from the subsequent tabular creamery records of the station. (See "Feeding Experiment," chapter IV., creamery record of the Massachusetts State Agricultural Experiment Station during the years 1885 to 1889, contained in this report.)



## II. FEEDING EXPERIMENTS WITH MILCH COWS; GREEN CROPS *vs.* ENGLISH HAY. JUNE 19 TO OCT. 22, 1889.

The first experiment in this direction was instituted in 1887, for the purpose of comparing the feeding effects of good English hay with that of some reputed green fodders. The green crops selected for our observation consisted of a mixed crop of oats and vetch, of Southern cow-pea and of serradella.

1887. — Five cows were engaged in the trial. Two cows were fed with a daily fodder ration consisting of corn meal,  $3\frac{1}{4}$  pounds (2 quarts); wheat bran,  $3\frac{1}{4}$  pounds (4 quarts); English hay, 20 to 24 pounds. The excess of hay left over was weighed back and subsequently deducted from the original quantity (about  $\frac{1}{8}$  to  $\frac{1}{4}$  pound per day).

Three cows received periodically the above-stated daily rations, and alternately the following: corn meal,  $3\frac{1}{4}$  pounds; wheat bran,  $3\frac{1}{4}$  pounds; English hay, 5 pounds; and as much of either green vetch and oats, green Southern cow-pea or green serradella, as the individual animal would consume. They consumed per day, on an average, from 64 to 65 pounds of green vetch and oats; of green Southern cow-pea, 96 to 97 pounds; and in case of green serradella, from 97 to 98 pounds. The feeding of the green crop commenced in every instance with the beginning of the blooming period. The rate of consumption of green crops decreased gradually with the progress of their growth.

The feeding of the different green fodders, in place of three-fourths of the customary daily rations of English hay, gave, on the whole, very satisfactory results. For details, we have to refer to the fifth annual report of the station.

1888. — The experiment was repeated with some modifications. A mixed crop of vetch and oats, of Southern cow-pea and of serradella, was raised for that purpose. The latter crop suffered seriously from blight, and was not fit for feeding.

The quantity of green fodder fed at stated times was somewhat less in pounds than in the trial during the preceding year, on account of the addition of gluten meal to the fodder ration of that year. The daily diet (1888)

consisted of corn meal,  $3\frac{1}{4}$  pounds; wheat bran,  $3\frac{1}{4}$  pounds; gluten meal,  $3\frac{1}{4}$  pounds; English hay, 5 pounds; and as much vetch and oats or cow-pea as the animal would consume, which amounted, in the case of green vetch and oats, to from 54 to 68 pounds; and in that of green Southern cow-pea, from 70 to 80 pounds. One-fourth (five pounds) of the ordinary daily hay ration was retained in our green fodder diet, for the purpose of preventing disorders in the digestion of a liberal quantity of green fodder.

The nutritive ratio of the green fodder diet was a closer one than on former occasions, varying from 1 : 4.5 to 1 : 5.5. The nutritive effect was very satisfactory, for the animals, without exception, maintained their original weight; the yield of milk was in every instance somewhat raised, and the quality of the milk was equal to the best, as far as one and the same animal was concerned. The net cost of the feed for the production of one quart of milk was in most instances lower than in case of a whole English hay ration.

The cost of green fodder is based on that of hay, \$15 per ton; allowing two tons of hay, with fifteen per cent. of moisture, as the average produce of English hay per acre. This mode of valuation has been adopted, as on previous occasions, on account of the entire absence of market prices, as far as green vetch, cow-pea and serradella are concerned. These crops, as a rule, rank higher in the scale of an agricultural valuation than the meadow grass.

*Valuation per Ton of the Fodder Articles. (1888.)*

Corn meal, . . .	\$24 00	Vetch and oats (green), . .	\$2 75
Corn and cob meal, . .	20 70	Cow-pea (green), . .	3 14
Wheat bran, . . .	22 50	Serradella (green), . .	3 16
Gluten meal, . . .	22 50	Rowen, . . .	15 00
English hay, . . .	15 00		

1889. — Six cows at a time served in the trial; the observation began in June and closed in October, 1889. The course adopted during the preceding year was adhered to in every essential point. The daily diet consisted of  $3\frac{1}{4}$  pounds each of corn meal, wheat bran and gluten meal, with 5 pounds of hay, and all the green vetch and oats, green cow-pea or green serradella called for by each individual

cow. The amount actually consumed per day varied in case of vetch and oats from 30 to 55 pounds; of cow-pea, from 66 to 84 pounds; and, in case of serradella, from 63 to 85 pounds; showing but little preference for one as compared with the others. The difference in the daily consumption of the green fodders was due largely to their variations in dry vegetable matter during the progress of the experiment. The experiment was sub-divided into five feeding periods, beginning and ending with a hay fodder ration. The daily waste of coarse feed amounted per head to four pounds in case of oats and vetch, to two pounds in case of serradella, to one and one-half pounds in case of cow-pea; and, in case of hay, to one-half pound.

The results obtained fully sustain the conclusions presented in our previous reports, namely:—

1. The weight of dry vegetable matter contained in the feed consumed for the production of one quart of milk is less in case of the green fodder rations than in the hay ration; indicating a superior nutritive value of the former, as compared with the latter.

2. The yield of milk is in every instance increased, when changing from a hay ration to a green fodder ration.

3. The quality of milk is but slightly altered in case of different cows; the solids in some instances are slightly increased, in others they are slightly decreased. The creamery record, as will be seen from subsequent abstracts, is very satisfactory in case of the green fodder rations.

4. The net cost of feed for the production of milk is in every instance less in case of green fodder rations than in the hay ration.

5. The weight of the animal has in most instances increased towards the close of the experiment.

*Valuation of Fodder Articles for the Months of June to October of the Year 1889.*

	Per Ton.		Per Ton.
Corn meal, . . .	\$19 00	Cow-pea, . . .	\$3 14
Wheat bran, . . .	18 50	Serradella, . . .	3 16
Gluten meal, . . .	22 00	Hay, . . .	15 00
Vetch and oats, . . .	2 75		

## FEEDING RECORD.

JESSIE: Age, five years; grade, Jersey; last calf, Jan. 12, 1889.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Amount of Dry Vegetable Matter contained in the Daily Ration (in Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Each Feeding Period.
	Corn Meal.	Wheat Bran.	Gluten Meal.	Hay.	Vetch and Oats.	Cow-pea.	Serradella.				
1888.											
June 19 to June 27, . . . . .	3.25	3.25	3.25	18.70	—	—	—	25.56	10.90	1: 6.23	819
July 2 to July 15, . . . . .	3.25	3.25	3.25	3.64	55.43	—	—	23.89	10.59	1: 6.52	833
Sept. 1 to Sept. 10, . . . . .	3.25	3.25	3.25	5.00	—	84.90	—	27.43	11.74	1: 6.12	823
Sept. 15 to Sept. 27, . . . . .	3.25	3.25	3.25	5.00	—	—	85.77	27.18	11.00	1: 4.68	805
Oct. 4 to Oct. 22, . . . . .	3.25	3.25	3.25	19.74	—	—	—	26.50	9.51	1: 6.29	855

FLORA: Age, five years; grade, Durham; last calf, Dec. 22, 1888.

June 19 to June 24, . . . . .	3.25	3.25	3.25	18.80	—	—	—	25.65	11.71	1: 6.24	940
July 2 to July 15, . . . . .	3.25	3.25	3.25	5.00	30.14	—	—	19.71	10.01	1: 6.01	904
Sept. 1 to Sept. 10, . . . . .	3.25	3.25	3.25	5.00	—	80.90	—	26.85	13.51	1: 6.07	932
Sept. 15 to Sept. 27, . . . . .	3.25	3.25	3.25	5.00	—	—	79.54	26.16	11.72	1: 4.70	980
Oct. 4 to Oct. 22, . . . . .	3.25	3.25	3.25	17.79	—	—	—	24.74	10.69	1: 6.17	974

## FEEDING RECORD — Continued.

EVA: Age, nine years; grade, Jersey; last calf, Oct. 7, 1888.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.							Amount of Dry Vegetable Matter contained in the Daily Ration consumed (in Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Feeding Period.
	Corn Meal.	Wheat Bran.	Gluten Meal.	Hay.	Vetch and Oats.	Cow-peas.	Serradella.					
1889.												
June 19 to June 27, . . . . .	3.25	3.25	3.25	17.20	—	—	—	24.20	10.04	2.41	1: 6.13	1,044
July 2 to July 15, . . . . .	3.25	3.25	3.25	5.00	41.79	—	—	22.24	9.88	2.25	1: 6.30	1,039
Sept. 1 to Sept. 10, . . . . .	3.25	3.25	3.25	5.00	—	83.50	—	27.30	11.41	2.39	1: 6.11	1,015
Sept. 15 to Sept. 27, . . . . .	3.25	3.25	3.25	5.00	—	—	82.46	26.64	9.13	2.92	1: 4.69	1,039
Oct. 4 to Oct. 22, . . . . .	3.25	3.25	3.25	19.26	—	—	—	26.07	8.21	3.18	1: 6.26	1,078

ANNIE: Age, six years; grade, Jersey; last calf, June 19, 1888.

June 19 to June 27, . . . . .	3.25	3.25	3.25	16.00	—	—	—	23.12	10.03	2.31	1:6.06	909
Sept. 1 to Sept. 10, . . . . .	3.25	3.25	3.25	5.00	—	66.30	—	24.38	10.64	2.29	1:5.97	903
Sept. 15 to Sept. 27, . . . . .	3.25	3.25	3.25	5.00	—	—	63.15	23.48	9.04	2.60	1:4.74	898
Oct. 4 to Oct. 22, . . . . .	3.25	3.25	3.25	17.32	—	—	—	24.31	8.39	2.90	1:6.14	936

FEEDING RECORD — *Concluded.*

ELSIE: *Age, six years; grade, Holstein; last calf, Feb. 26, 1889.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Amount of Dry Vegetable Matter contained in the Daily Ration (in Pounds).	Quarts of Milk produced per day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Feeding Period.
	Corn Meal.	Wheat Bran.	Gluten Meal.	Hay.	Veitch and Oats.	Cow-pea.	Serradella.				
1889.											
June 19 to June 27, . . . . .	3.25	3.25	3.25	20.00	—	—	—	26.74	10.58	2.53	1:6.31
July 2 to July 15, . . . . .	3.25	3.25	3.25	5.00	55.29	—	—	25.18	10.25	2.46	1:6.60
Sept. 1 to Sept. 10, . . . . .	3.25	3.25	3.25	5.00	—	69.60	—	24.94	9.98	2.51	1:5.99
Sept. 15 to Sept. 27, . . . . .	3.25	3.25	3.25	5.00	—	—	77.08	25.76	9.22	2.79	1:4.70
Oct. 4 to Oct. 22, . . . . .	3.25	3.25	3.25	19.95	—	—	—	26.69	8.51	3.14	1:6.31
											1,148
											1,145
											1,132
											1,141
											1,188

JUNO: *Age, six years; grade, Ayrshire; last calf, June 22, 1889.*

July 2 to July 15, . . . . .	3.25	3.25	3.25	5.00	49.36	—	—	23.89	14.74	1.62	1:6.47	975
Sept. 1 to Sept. 10, . . . . .	3.25	3.25	3.25	5.00	—	72.80	—	25.48	14.74	1.73	1:6.02	1,014
Sept. 15 to Sept. 27, . . . . .	3.25	3.25	3.25	5.00	—	—	81.33	26.46	12.93	2.05	1:4.69	984
Oct. 4 to Oct. 22, . . . . .	3.25	3.25	3.25	21.74	—	—	—	28.31	12.15	2.33	1:6.40	1,040

## TOTAL COST OF FEED PER QUART OF MILK.

*Annie.*

FEEDING PERIODS.				Total Quantity of Milk produced.	Average Daily Yield of Milk.	Total Amount of Corn consumed.	Total Amount of Wheat Bran consumed.	Total Amount of Gluten Meal consumed.	Total Amount of Hay consumed.	Total Amount of Vetch and Oats consumed.	Total Amount of Cow-peas consumed.	Total Amount of Bertramella consumed.	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk.
1899.				Qts.	Qts.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cents.	Cents.
June 19 to June 27,	.	.	.	90.25	10.03	29.25	29.25	29.25	144.00	—	—	—	\$1 95	2.16
Sept 1 to Sept. 10,	.	.	.	106.38	10.64	32.50	32.50	32.50	50.00	—	663.00	—	2 38	2.24
Sept. 15 to Sept. 27,	.	.	.	117.50	9.04	42.25	42.25	42.25	65.00	—	—	821.00	3 04	2.59
Oct. 4 to Oct. 22,	.	.	.	159.38	8.39	61.75	61.75	61.75	329.00	—	—	—	4 30	2.70

*Elsie.*

June 19 to June 27,	.	.	.	95.25	10.58	29.25	29.25	29.25	180.00	—	—	—	\$2 22	2.33
July 2 to July 15,	.	.	.	143.50	10.25	45.50	45.50	45.50	70.00	774.00	—	—	2 94	2.05
Sept. 1 to Sept. 10,	.	.	.	99.25	9.93	32.50	32.50	32.50	60.00	—	696.00	—	2 43	2.45
Sept. 15 to Sept. 27,	.	.	.	119.88	9.22	42.25	42.25	42.25	65.00	—	—	1,002.00	3 33	2.78
Oct. 4 to Oct. 22,	.	.	.	161.63	8.51	61.75	61.75	61.75	379.00	—	—	—	4 68	2.89

*June.*

July 2 to July 15,	.	.	.	206.38	14.74	45.50	45.50	45.50	70.00	691.00	—	—	\$2 83	1.37
Sept. 1 to Sept. 10,	.	.	.	147.38	14.74	32.50	32.50	32.50	50.00	—	728.00	—	2 49	1.69
Sept. 15 to Sept. 27,	.	.	.	168.13	12.93	42.25	42.25	42.25	65.00	—	—	1,058.00	3 42	2.03
Oct. 4 to Oct. 22,	.	.	.	230.88	12.15	61.75	61.75	61.75	413.00	—	—	—	4 93	2.14

TOTAL COST OF FEED PER QUART OF MILK — Continued.  
*Jessie.*

FEEDING PERIODS.	Total Quantity of Milk produced.	Average Daily Yield of Milk.	Total Amount of Corn consumed.	Total Amount of Wheat consumed.	Total Amount of Gluten consumed.	Total Amount of Hay consumed.	Total Amount of Vetch and Oats consumed.	Total Amount of Cow-peas consumed.	Total Amount of Serradella consumed.	Total Cost of feed consumed.	Average Cost of Feed for Production of One Quart of Milk.
	Qts.	Qts.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	\$	Cents.
<b>1889.</b>											
June 19 to June 27, . . . . .	98.13	10.90	29.25	29.55	29.25	168.00	—	—	—	\$2 13	2.17
July 2 to July 15, . . . . .	148.25	10.59	45.50	45.50	45.50	51.00	776.00	—	—	2 81	1.89
Sept. 1 to Sept. 10, . . . . .	117.38	11.74	32.50	32.50	32.50	50.00	—	843.00	—	2 67	2.27
Sept. 15 to Sept. 27, . . . . .	143.00	11.00	42.25	42.25	42.25	65.00	—	—	1,115.00	3 51	2.45
Oct. 4 to Oct. 22, . . . . .	180.75	9.51	61.75	61.75	61.75	375.00	—	—	—	4 64	2.56
<b>Flora.</b>											
June 19 to June 24, . . . . .	70.25	11.71	19.50	19.50	19.50	113.00	—	—	—	\$1 43	2.04
July 2 to July 15, . . . . .	140.13	10.01	45.50	45.50	45.50	70.00	422.00	—	—	2 46	1.76
Sept. 1 to Sept. 10, . . . . .	135.13	13.51	32.50	32.50	32.50	50.00	—	809.00	—	2 61	1.93
Sept. 15 to Sept. 27, . . . . .	152.38	11.72	42.25	42.25	42.25	65.00	—	—	1,034.00	3 88	2.22
Oct. 4 to Oct. 22, . . . . .	203.13	10.69	61.75	61.75	61.75	338.00	—	—	—	4 37	2.15



## TOTAL COST OF FEED PER QUART OF MILK — Concluded.

Eva.

FEEDING PERIODS	Total Quantity of Milk produced.	Average Daily Yield of Milk.	Total Amount of Corn meal consumed.	Total Amount of Wheat Bran consumed.	Total Amount of Gluten Meal consumed.	Total Amount of Hay consumed.	Total Amount of Vetch and Oats consumed.	Total Amount of Cow-peas consumed.	Total Amount of Bertramella consumed.	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk.
	Qts.	Qts.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cents.	Cents.
1899.											
June 19 to June 27, . . . . .	90.38	10.04	29.25	29.25	29.25	155.00	—	—	—	\$2.03	2.25
July 2 to July 15, . . . . .	137.38	9.88	45.50	45.50	45.50	70.00	685.00	—	—	2.82	2.06
Sept. 1 to Sept. 10, . . . . .	114.13	11.41	32.50	32.50	32.50	50.00	—	835.00	—	2.65	2.32
Sept. 15 to Sept. 27, . . . . .	118.75	9.13	42.25	42.25	42.25	65.00	—	—	1,072.00	3.44	2.90
Oct. 4 to Oct. 22, . . . . .	156.00	8.21	61.75	61.75	61.75	366.00	—	—	—	4.58	2.94

*Valuation of Essential Fertilizing Constituents contained in the Various Articles of Fodder used.*

Nitrogen, 17 cents per pound; phosphoric acid, 6 cents; potassium oxide, 4½ cents. (1889.)

[Per cent.]

	Corn Meal.	Wheat Bran.	Gluten Meal.	Hay.	Vetch and Oats.	Cow-pea.	Serradella.
Moisture, . . .	13.290	10.92	10.19	9.48	78 26	83.07	83.65
Nitrogen, . . .	1.564	2.447	4.230	1.463	.268	.304	.470
Phosphoric acid, . .	.720	2.900	.392	.303	.112	.098	.112
Potassium oxide, . .	.434	1.637	.049	1.350	.324	.172	.178
Valuation per 2,000 lbs.,	\$6 57	\$13 27	\$14 90	\$6 55	\$1 34	\$1 31	\$1 89

NET COST OF MILK AND MANURIAL VALUE OF FEED.

*Jessie.*

FEEDING PERIODS.	Total Cost of Feed consumed during Period.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting the Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
<b>1889.</b>					Cents.	Lbs.
June 19 to June 27, .	\$2 13	\$0 98	\$0 78	\$1 35	1.38	838
July 2 to July 15, .	2 81	1 48	1 18	1 63	1.10	840
Sept. 1 to Sept. 10, .	2 67	1 28	1 02	1 65	1.41	810
Sept. 15 to Sept. 27, .	3 51	2 00	1 60	1 91	1.34	820
Oct. 4 to Oct. 22, .	4 64	2 30	1 84	2 80	1.55	888
Total, . . .	\$15 76	\$8 04	\$6 42	\$9 34	—	—

*Flora.*

June 19 to June 24, .	\$1 43	\$0 71	\$0 57	\$0 86	1.22	952
July 2 to July 15, .	2 46	1 30	1 04	1 42	1.01	905
Sept. 1 to Sept. 10, .	2 61	1 26	1 01	1 60	1.18	938
Sept. 15 to Sept. 27, .	3 38	1 92	1 54	1 84	1.21	933
Oct. 4 to Oct. 22, .	4 37	2 18	1 74	2 63	1.29	1,000
Total, . . .	\$14 25	\$7 37	\$5 90	\$8 35	—	—

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## NET COST OF MILK AND MANURIAL VALUE OF FEED — *Concluded.*

### *Eva.*

FEEDING PERIODS.	Total Cost of Feed consumed during Period.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of Feed after deducting the Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
<b>1889.</b>					Cents.	Lbs.
June 19 to June 24, .	\$2 03	\$0 94	\$0 75	\$1 28	1.42	1,046
July 2 to July 15, .	2 82	1 48	1 18	1 64	1.19	1,080
Sept. 1 to Sept. 10, .	2 65	1 27	1 02	1 63	1.43	1,030
Sept. 15 to Sept. 27, .	3 44	1 96	1 57	1 87	1.58	1,038
Oct. 4 to Oct. 22, .	4 58	2 27	1 82	2 76	1.77	1,109
Total, . .	\$15 52	\$7 92	\$6 34	\$9 18	—	—

### *Annie.*

June 19 to June 27, .	\$1 95	\$0 91	\$0 73	\$1 22	1.35	915
Sept. 1 to Sept. 10, .	2 38	1 16	93	1 45	1.36	888
Sept. 15 to Sept. 27, .	3 04	1 72	1 38	1 66	1.41	896
Oct. 4 to Oct. 22, .	4 30	2 15	1 72	2 58	1.62	976
Total, . .	\$11 67	\$5 94	\$4 76	\$6 91	—	—

### *Elsie.*

June 19 to June 27, .	\$2 22	\$1 01	\$0 81	\$1 41	1.48	1,150
July 2 to July 15, .	2 94	1 54	1 23	1 71	1.19	1,142
Sept. 1 to Sept. 10, .	2 43	1 18	94	1 49	1.50	1,134
Sept. 15 to Sept. 27, .	3 33	1 89	1 51	1 82	1.52	1,148
Oct. 4 to Oct. 22, .	4 68	2 31	1 85	2 83	1.75	1,210
Total, . .	\$15 60	\$7 93	\$6 34	\$9 26	—	—

### *Juno.*

July 2 to July 15, .	\$2 83	\$1 48	\$1 18	\$1 65	.80	990
Sept. 1 to Sept. 10, .	2 49	1 20	96	1 53	1.04	1,010
Sept. 15 to Sept. 27, .	3 42	1 95	1 56	1 86	1.11	978
Oct. 4 to Oct. 22, .	4 93	2 42	1 94	2 99	1.29	1,046
Total, . .	\$13 67	\$7 05	\$5 64	\$8 03	—	—

## ANALYSES OF MILK.

[Per cent.]

*Jessie.*

1899.	June 25.	July 16.	Sept. 12.	Sept. 24.	Oct. 15.
Solids, . . . .	14.76	15.03	13.90	15.43	14.74
Fat, . . . .	5.36	5.32	4.74	5.56	5.33
Solids not fat, . . . .	9.41	9.71	9.16	9.87	9.41

*Flora.*

Solids, . . . .	15.56	13.33	12.46	14.11	13.35
Fat, . . . .	4.78	3.76	3.33	4.36	4.10
Solids not fat, . . . .	10.78	9.57	9.13	9.75	9.25

*Eva.*

Solids, . . . .	14.79	15.06	14.07	16.25	16.25
Fat, . . . .	4.89	5.13	4.65	6.00	6.10
Solids not fat, . . . .	9.90	9.93	9.42	10.25	10.15

*Annie.*

Solids, . . . .	14.18	14.20	14.12	15.71	15.68
Fat, . . . .	4.39	4.65	4.55	5.12	5.18
Solids not fat, . . . .	9.79	9.55	9.57	10.59	10.50

*Elsie.*

Solids, . . . .	12.70	13.05	12.29	13.33	12.82
Fat, . . . .	3.45	3.52	3.42	5.17	3.55
Solids not fat, . . . .	9.25	9.53	8.87	8.16	9.27

*Juno.*

Solids, . . . .	—	12.53	11.35	12.87	13.22
Fat, . . . .	—	2.93	2.78	4.11	4.03
Solids not fat, . . . .	—	9.60	8.57	8.76	9.19

## COMPOSITION OF FODDER ARTICLES FED DURING THIS EXPERIMENT.

*Corn Meal (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.	
Moisture at 100° C., . . .	13.29	265.80	-	-	} 1:9.09	
Dry matter, . . . . .	86.71	1,734.20	-	-		
	100.00	2,000.00	-	-		
<i>Analysis of Dry Matter.</i>						
Crude ash, . . . . .	1.67	33.40	-	-		
“ cellulose, . . . . .	1.69	33.80	11.49	34		
“ fat, . . . . .	4.04	80.80	61.41	76		
“ protein (nitrogenous matter), . . . . .	11.00	220.00	187.00	85		
Non-nitrogenous extract matter, . . . . .	81.60	1,632.00	1,534.08	94		
	100.00	2,000.00	1,793.98	-		

*Wheat Bran (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.	
Moisture at 100° C., . . .	10.92	218.40	-	-	} 1 : 8.99	
Dry matter, . . . . .	89.08	1,781.60	-	-		
	100.00	2,000.00	-	-		
<i>Analysis of Dry Matter.</i>						
Crude ash, . . . . .	7.00	140.00	-	-		
“ cellulose, . . . . .	11.52	230.40	46.08	20		
“ fat, . . . . .	5.43	108.60	86.88	80		
“ protein (nitrogenous matter), . . . . .	17.17	343.40	302.19	88		
Non-nitrogenous extract matter, . . . . .	58.88	1,177.60	942.08	80		
	100.00	2,000.00	1,377.23	-		

COMPOSITION OF FODDER ARTICLES, ETC. — *Continued.**Gluten Meal (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	10.19	203.80	—	—	1 : 2.86
Dry matter, . . . . .	89.81	1,796.20	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	.57	11.40	—	—	
“ cellulose, . . . . .	.56	11.20	3.81	34	
“ fat, . . . . .	6.40	128.00	97.28	76	
“ protein (nitrogenous matter), . . . . .	29.45	589.00	500.65	85	
Non-nitrogenous extract matter, . . . . .	63.02	1,260.40	1,184.78	94	
	100.00	2,000.00	1,786.52	—	

*Hay (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	9.48	189.60	—	—	1 : 8.99
Dry matter, . . . . .	90.50	1,810.40	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	7.12	142.40	—	—	
“ cellulose, . . . . .	33.22	664.40	385.35	58	
“ fat, . . . . .	2.30	46.00	21.16	46	
“ protein (nitrogenous matter), . . . . .	10.09	201.80	115.03	57	
Non-nitrogenous extract matter, . . . . .	47.27	945.40	595.60	63	
	100.00	2,000.00	1,117.14	—	

COMPOSITION OF FODDER ARTICLES, ETC. — *Continued.**Vetch and Oats.*

[Experiment Station, 1889.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	78.26	1,565.20	—	—	1 : 11.26
Dry matter, . . . . .	21.74	434.80	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	4.53	90.60	—	—	
“ cellulose, . . . . .	36.22	724.40	—	—	
“ fat, . . . . .	2.53	50.60	25.30	50	
“ protein (nitrogenous matter), . . . . .	7.72	154.40	92.64	60	
Non-nitrogenous extract matter, . . . . .	49.00	980.00	980.00	100	
	100.00	2,000.00	1,097.94	—	

*Cow-pea.*

[Experiment Station, 1889.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	83.07	1,661.40	—	—	1 : 7.46
Dry matter, . . . . .	16.93	338.60	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	7.35	147.00	—	—	
“ cellulose, . . . . .	21.87	437.40	205.58	47	
“ fat, . . . . .	2.99	59.80	35.28	59	
“ protein (nitrogenous matter), . . . . .	11.24	224.80	134.88	60	
Non-nitrogenous extract matter, . . . . .	56.55	1,131.00	712.53	69	
	100.00	2,000.00	1,088.27	—	

COMPOSITION OF FODDER ARTICLES, ETC.—*Concluded.**Serradella.*

[Experiment Station, 1889.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	83.65	1,673.00	—	—	} 1 : 4.27
Dry matter, . . . . .	16.35	327.00	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	8.94	178.80	—	—	
" cellulose, . . . . .	25.92	518.40	—	—	
" fat, . . . . .	2.38	47.60	28.56	60	
" protein (nitrogenous matter), . . . . .	17.97	359.40	226.42	63	
Non-nitrogenous extract matter, . . . . .	44.79	895.80	895.80	100	
	100.00	2,000.00	1,150.78	—	

*Vetch and Oats. (1889.)*

[Left uneaten by the cows during experiment.]

	Per Cent.
Moisture at 100° C., . . . . .	4.94
Dry matter, . . . . .	95.06
	100.00
<i>Analysis of Dry Matter.</i>	
Crude ash, . . . . .	4.61
" cellulose, . . . . .	36.72
" fat, . . . . .	1.79
" protein (nitrogenous matter), . . . . .	10.52
Non-nitrogenous extract matter, . . . . .	46.36
	100.00



### III. RECORD OF TWELVE COWS WHICH SERVED AT THE STATION FOR EXPERIMENTS TO ASCERTAIN THE COST OF FEED FOR THE PRODUCTION OF MILK.

When entering at this station upon the task of ascertaining the cost of feed for the production of milk (1884), it was decided to begin the inquiry with cows of moderate milking qualities. Grades of all kinds of breeds were to serve for that purpose. A selection from that class of cows, at the outset of our observation, promised to prove of a special interest, not only on account of their large representation in our dairy stock, but also for the particular chance which our final results would offer to draw more directly the line where milk production ceases to be a profitable business. The material for the subsequent report has been carefully collected during a period of several years. The results, it is true, are obtained under somewhat exceptional circumstances; yet their detailed description cannot fail to show more clearly the financial relation of milk production to a system of a mixed farm management.

The cows which served in our trials were in every instance secured a few days after calving. They were sold to the butcher usually when their daily yield of milk fell below from five to six quarts, to make room for a new-milch cow. The cost of the different animals varied from fifty-five to seventy-two dollars each; they sold at the close of their trial for from twenty-five to thirty-seven dollars each.

The management of the entire experiment was conducted with a view to promote the general health of the animals on trial. Two cows had lost in weight during the experiment, and ten had gained more or less. The change from one diet to another was as a rule a gradual one.

The temporary change in the composition of the daily diet was mainly confined to the coarser and bulky fodder ingredients. English hay, dry fodder corn, corn stover, corn ensilage and roots, besides some small quantity of various dried fodder crops, incidental to some field experiments with forage crops, were fed during the latter part of autumn, the winter and the spring; while several green crops, as oats or barley and vetch, serradella and cow-peas, were substituted during the summer and part of the fall season. The several previously named fodder crops served in the majority of

cases either in part or in the whole as substitutes for English hay.

The daily rations of grain fed consisted throughout the entire period, in all cases alike, substantially of the same materials; namely, corn meal or corn and cob meal, and wheat bran, which were supplemented, in the majority of instances, more or less by gluten meal, to secure as far as practicable the desired comparative nutritive character of the diet. The daily diet per head consisted of from eighteen to twenty or more pounds of hay, or its equivalent in part or in the whole of dry vegetable matter of the above-mentioned bulky fodder articles, and from six and one-half to nine and three-quarters pounds of grain feed, usually composed of corn meal or corn and cob meal, and wheat bran, with or without gluten meal (three and one-fourth pounds).

The ruling local average market price of each fodder article has been used for the determination of the cost of feed consumed. The estimates of fertilizing constituents contained in the various fodder articles used are based on our own analysis, and on their local market price during the past year. Twenty per cent. loss of the fertilizing constituents contained in the feed has been allowed for the amount sold with the milk.

The period of observation varied, in case of different cows, from 261 to 747 days; the average daily yield of milk per head for the whole period of observation varied from 7.7 to 12.4 quarts.

Three cents per quart of milk produced has been adopted as the average price realized for the entire year, in case of milk contracts in our vicinity.

The essential details of our observations are subsequently recorded in tabular form, under the following headings:—

1. History of cows.
2. Statement of the amount of each kind of fodder ingredients consumed by each animal, with total cost of feed for period of observation.
3. Local market value per ton of each fodder article used.
4. Value of essential fertilizing constituents contained in the various articles of fodder consumed.
5. Summary of financial record of cows.
6. Some conclusions suggested by the financial record.

## 1. History of Cows on Trial.

NAME AND AGE OF COW.	Breed (Grade).	Number of Calves.	Last Cal.	Date of Arrival.	Date of Departure.	Number of Days milked.	Total Yield of Milk during Observation (Quarts).	Average Yield of Milk per Day at Beginning of Observation (Quarts).	Average Yield of Milk per Month during Milk Month (Quarts).	Average Yield of Milk per Day at Close of Observation (Quarts).	Total Yield of Milk for First 300 Days of Observation (Quarts).	Average Yield of Milk per Day for First 300 Days of Observation (Quarts).	Live Weight of Animal at Beginning of Observation (Pounds).	Live Weight of Animal at Close of Observation (Pounds).
1. Beale, 8 yrs.,	Jersey, .	4	Oct. 17, 1884,	Oct. 23, 1884,	Oct. 31, 1885,	374	3,724.3	16.5	9.2	6.9	3,213.3	10.7	899	833
2. Lady Horace, 8 yrs.,	Ayrshire, .	4	Oct. 16, 1884,	Oct. 23, 1884,	Oct. 31, 1885,	374	4,063.5	16.7	9.8	7.9	3,486.3	11.6	931	970
3. Daisy (1), 7 yrs.,	Ayrshire, .	3	Nov. 10, 1885,	Nov. 17, 1885,	Sept. 16, 1886,	304	3,613.5	15.3	7.9	10.5	3,571.5	11.9	911	838
4. Mollie, 7 yrs.,	Ayrshire, .	3	Nov. 6, 1885,	Nov. 17, 1885,	Sept. 16, 1886,	307	3,124.6	12.1	8.1	8.5	3,063.5	10.2	891	880
5. Sue, 6 yrs.,	Ayrshire, .	2	July 14, 1886,	July 30, 1886,	May 3, 1887,	278	3,446.5	15.5	9.8	9.8	3,623.3*	12.2	849	1,025
6. Meg, 6 yrs.,	Devon, .	2	Aug. 2, 1886,	Aug. 16, 1886,	May 3, 1887,	261	3,223.8	17.2	10.8	10.9	3,623.8*	12.1	1,018	1,132
7. Lizzie, 6 yrs.,	Native, .	2	Aug. 1, 1887,	Feb. 5, 1887,	June 23, 1888,	503	6,023.8	19.7	9.2	8.3	4,176.8	13.9	995	1,102
8. Ida, 6 yrs.,	Durham, .	2	Feb. 1, 1887,	Feb. 5, 1887,	Jan. 3, 1888,	331	2,527.8	16.0	3.9	1.3	2,498.0	8.3	978	1,000
9. Minnie, 7 yrs.,	Durham, .	4	May 3, 1887,	May 17, 1887,	Dec. 23, 1888,	584	6,779.0	17.5	12.8	6.1	3,998.2	13.3	885	1,011
10. Daisy (2), 7 yrs.,	Durham, .	4	Jan. 6, 1888,	Jan. 16, 1888,	Jan. 19, 1889,	392	4,557.8	18.9	10.2	6.3	4,106.5	13.7	1,132	1,165
11. May, 8 yrs.,	Jersey, .	3	June 6, 1887,	June 13, 1887,	June 23, 1888,	747	7,843.5	14.3	12.0	9.6	3,419.0	11.4	917	990
12. Mella, 10 yrs.,	Dutch, .	7	Aug. 5, 1887,	Aug. 11, 1887,	Mar. 1, 1889,	569	6,366.6	14.3	11.8	7.1	3,366.5	12.9	904	1,115
Averages,	. . .	. . .	. . .	. . .	. . .	417	4,698.7	16.2	9.6	7.7	3,556.1	11.9	933	1,008

\* Estimated.

1890.]

2. Amount of Each of the Various Kinds of Feed consumed (in Pounds) by the Cows on Trial.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
	Boale.	Lady Horace.	Daisy (1).	Mollie.	Susie.	Meg.	Lizzie.	Ida.	Minnie.	Daisy (2).	May.	Molla.
Corn meal,	941.25	941.25	877.50	890.50	900.25	848.50	1,126.50	1,075.75	1,343.50	642.25	1,846.00	1,292.00
Corn and cob meal,	—	—	—	—	—	—	608.25	—	557.25	557.25	1,846.00	1,292.00
Wheat bran,	931.25	931.25	939.25	955.50	825.50	776.75	1,530.75	975.00	1,868.75	557.25	2,403.25	657.25
Rye middlings,	—	—	—	—	74.75	71.50	156.00	156.00	65.00	1,199.25	—	1,849.25
Oaten meal,	74.75	74.75	—	—	520.00	523.25	771.50	304.00	1,083.00	—	—	—
Hay,	4,228.75	5,122.00	2,962.00	2,780.00	4,073.50	3,311.50	7,418.75	4,925.25	1,083.00	1,134.50	1,683.25	1,312.50
Rowen,	324.75	408.00	435.00	473.00	399.50	500.00	1,533.25	1,268.00	6,886.00	4,554.50	8,086.50	6,656.50
Corn fodder (dry),	—	—	—	—	—	313.00	713.25	—	824.50	528.00	2,464.00	1,843.00
Corn stover (dry),	—	—	—	—	94.00	90.50	112.00	90.50	86.25	368.00	304.00	242.00
Corn ensilage,	2,098.00	2,148.00	2,990.00	2,959.00	930.00	826.50	878.00	—	1,017.25	1,539.25	2,415.00	2,150.00
Millet (dry),	156.00	119.00	37.00	32.00	—	—	—	—	—	—	—	—
Vetch and lucerne (dry),	72.00	98.00	—	—	—	—	—	—	—	—	—	—
Lucerne and clover (dry),	24.00	30.00	—	—	—	—	—	—	—	—	—	—
Oats (dry),	—	—	308.00	528.00	—	140.00	—	—	—	—	—	—
Oats (green),	—	—	585.00	583.00	70.00	—	—	—	2,059.50	1,051.00	2,206.00	998.00
Vetch and oats (green),	—	—	—	—	—	—	—	—	—	—	—	—
Vetch (green),	—	—	319.00	251.00	40.00	45.00	—	—	—	—	—	—
Serradella (green),	—	—	580.00	725.00	320.00	—	—	—	2,408.50	—	2,374.00	—
Cow-pea (green),	—	—	656.00	676.00	700.00	711.00	—	—	3,109.00	821.00	3,110.00	783.00
Barley and beans (green),	215.00	245.00	—	—	—	—	—	1,190.00	—	—	—	—
Potatoes,	—	—	—	—	—	—	—	—	—	—	—	—
Carrots,	—	—	—	—	—	—	—	—	—	—	—	—
Roots (sugar beets),	—	—	1,592.00	1,592.00	1,041.50	1,052.00	519.50	567.50	91.00	859.00	916.00	918.00
Total cost of feed,	\$59.00	\$65.65	\$56.46	\$56.04	\$63.25	\$59.50	\$118.96	\$80.08	\$135.05	\$88.33	\$174.60	\$130.51

*3. Local Market Value per Ton of the Various Articles of Fodder used.*

Corn meal, . . . . .	\$23 00		
Corn and cob meal, . . . . .	20 70		
Wheat bran, . . . . .	21 50		
Rye middlings, . . . . .	21 50		
Gluten meal, . . . . .	23 00		
Hay, . . . . .	\$15 00	Vetch and oats (green), . .	\$2 75
Rowen, . . . . .	15 00	Vetch (green), . . . . .	3 50
Corn fodder, . . . . .	5 00	Serradella (green), . . . .	3 16
Corn stover, . . . . .	5 00	Cow-pea (green), . . . . .	3 14
Corn ensilage, . . . . .	2 25	Barley and horse bean	
Millet (dry), . . . . .	12 00	(green), . . . . .	3 00
Lucerne and vetch (dry), . . . .	12 00	Potatoes, . . . . .	6 67
Lucerne and clover (dry), . . . .	12 00	Carrots, . . . . .	7 00
Oats (dry), . . . . .	12 00	Sugar beets, . . . . .	5 00
Oats (green), . . . . .	3 60		

*4. Valuation of the Essential Fertilizing Constituents contained in the Various Articles of Fodder used.*

Nitrogen, 16½ cents per pound; phosphoric acid, 6 cents; potassium oxide, 4½ cents.

[Per cent.]

	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Valuation per Ton.
Corn meal, . . . . .	1.86	0.77	0.45	\$7 44
Corn and cob meal, . . . . .	1.46	0.603	0.441	5 91
Wheat bran, . . . . .	2.82	3.05	1.49	14 24
Rye middlings, . . . . .	1.84	1.26	0.81	8 27
Gluten meal, . . . . .	5.22	0.40	0.05	17 75
Hay, . . . . .	1.25	0.464	2.085	6 46
Rowen, . . . . .	1.93	0.364	2.86	9 24
Corn fodder (dry), . . . . .	1.37	0.368	0.355	5 26
Corn stover (dry), . . . . .	0.78	0.09	0.599	3 19
Corn ensilage, . . . . .	0.36	0.14	0.33	1 64
Millet (dry), . . . . .	1.106	0.38	2.49	6 23
Lucerne and vetch (dry), . . . .	2.02	0.70	2.273	9 44
Lucerne and clover (dry), . . . .	2.06	0.623	1.805	9 08
Oats (dry), . . . . .	1.47	0.51	2.41	7 51
Oats (green), . . . . .	0.33	0.155	0.68	1 85
Vetch and oats (green), . . . . .	0.23	0.09	0.79	1 54
Vetch (green), . . . . .	0.49	0.20	0.66	2 42
Serradella (green), . . . . .	0.411	0.14	0.423	1 89
Cow-pea (green), . . . . .	0.561	0.098	0.306	2 23
Barley and beans (green), . . . .	0.50	0.20	0.40	2 23
Potatoes, . . . . .	0.476	0.18	0.56	2 18
Carrots, . . . . .	0.14	0.10	0.54	1 04
Sugar beets, . . . . .	0.29	0.03	0.18	1 15

## 5. Summary of Financial Record of Cows.

NAME OF COW.	Total Value of Milk at Three Cents per Quart.	Total Cost of Feed consumed.	Manutrial Value of Food, less Twenty Per Cent. taken by Milk.	Net Cost of Feed.	Original Cost of Cow.	Selling Price of Cow.	Total Value re- ceived above Net Cost of Feed and of Cow.	Value received in Form of Manure.	Value received in Form of Cash.	Total Value re- ceived per Day.
										Cents.
1. Bessie, . . .	\$111 73	\$59 00	\$22 27	\$36 73	\$65 00	\$25 00	\$35 00	\$22 27	\$12 73	9.36
2. Lady Horace, . . .	121 90	65 65	24 69	40 96	65 00	26 50	42 44	24 69	17 75	11.35
8. Daisy (1), . . .	108 41	56 46	21 95	34 51	60 00	25 00	38 90	21 95	16 95	12.80
4. Mollie, . . .	93 74	56 04	22 24	33 80	60 00	25 00	24 94	22 24	2 70	8.12
5. Susie, . . .	103 40	63 25	24 81	38 44	60 00	37 40	42 36	24 81	17 55	15.24
6. Meg, . . .	97 01	59 50	23 84	35 67	60 00	37 54	38 88	23 83	15 05	14.90
7. Lizzie, . . .	180 70	118 96	47 64	71 32	65 00	28 00	72 38	47 64	24 74	14.89
8. Ida, . . .	75 83	80 08	30 28	49 80	55 00	25 00	3 97	30 28	34 25	-1.20
9. Minnie, . . .	203 87	135 05	56 93	78 12	60 00	28 00	98 25	56 93	36 32	15.97
10. Daisy (2), . . .	136 33	88 33	37 94	50 39	72 50	35 00	48 44	37 94	10 50	13.13
11. May, . . .	235 81	174 60	73 35	101 25	60 00	30 00	104 06	73 35	80 71	13.93
12. Mella, . . .	191 00	130 51	54 50	76 01	65 00	30 00	79 99	54 50	25 49	14.06
Averages, . . .	\$138 23	\$90 62	\$36 70	\$53 92	\$62 29	\$29 38	\$51 40	\$36 70	\$14 70	11.83

Average cost of cow (twelve), . . . . .	\$62 29
Average selling price of cow, . . . . .	29 38
Average of total cost of feed per day, . . . . .	21.54 cents.
Average product per day for entire observation, per head, . . . . .	11.06 quarts.
Average of net cost of feed per day, . . . . .	12.94 cents.
Average of value received above net cost of feed and of cow, per day, . . . . .	12.33 cents.
Average of value received in form of manure, per day, . . . . .	8.81 cents.
Average of value received in form of cash, per day, . . . . .	3.52 cents.

The average yield of milk at the end of the ninth month, since day of calving, was sixty-one per cent. of original yield. The shrinkage in the temporary market value of cow varies from five to eleven and four-tenths cents per day, and averages eight cents per head in our case.

The net cost of the feed consumed is obtained by deducting eighty per cent. of the current commercial value of the essential fertilizing constituents contained in the feed from the market cost of the feed. See —

*Bessie.*

Market value of feed consumed, . . . . .	\$59 00
Value of manure obtainable, . . . . .	22 27
Net cost of feed, . . . . .	<u>\$36 73</u>

The total value obtained for the feed consumed is ascertained by adding the value secured from the sale of milk produced to the commercial value represented in the manure obtainable. See —

*Bessie.*

Value of milk sold, . . . . .	\$111 73
Value of eighty per cent. of the manurial substances in the feed, . . . . .	22 27
Total value obtained from feed consumed, . . . . .	<u>\$134 00</u>

The total value secured from any individual cow, after net cost of feed and of cow has been accounted for, is represented by subtracting the sum resulting from the addition of the difference between the original cost of the cow and its selling price, and of the total cost of feed consumed, from the total value obtained in form of milk and manurial refuse. See —

<i>Bessie.</i>									
Original cost of cow,	.	.	.	.	.	.	.	.	\$65 00
Selling price of cow,	.	.	.	.	.	.	.	.	25 00
Difference,	.	.	.	.	.	.	.	.	\$40 00
Loss on cow,	.	.	.	.	.	.	.	.	\$40 00
Total cost of feed,	.	.	.	.	.	.	.	.	59 00
									\$99 00
Total value obtained from feed,	.	.	.	.	.	.	.	.	\$134 00
Total cost of feed and loss on cow,	.	.	.	.	.	.	.	.	99 00
Net return for feed,	.	.	.	.	.	.	.	.	\$35 00

It seems to be scarcely necessary to add that the above estimates refer only to the cost of feed and of the cow, and do not include cost of labor, housing, interest and risk of life of animal, etc.

#### 6. *Some Conclusions suggested by the Preceding Financial Record.*

1. The total value received above net cost of feed and of cow does in no instance exceed 15.97 cents per day; its average in eleven cases is 13.02 cents. There is an actual loss of 1.2 cents per day in one case (No. 8), where the average daily yield of milk for the entire period of observation (331 days) is as low as 7.7 quarts.

2. The total value received above net cost of feed and of cow consists in every instance in a controlling degree on the manure obtainable. In No. 8 it prevents a serious loss, while in No. 4 it represents practically the entire gain; in some instances it amounts to from three-fourths to two-thirds (Nos. 12 and 3), and in none as low as one-half of the total value secured.

3. As the value of the manure depends in a controlling degree on the amount of fertilizing constituents contained in the feed, it becomes apparent that this point ought to be seriously considered when selecting suitable fodder articles for a remunerative daily diet of dairy cows. The table containing the valuation of the essential fertilizing constituents of the fodder articles used in our experiments is very sug-



gestive in this connection, when compared with the preceding statements of respective market prices of the latter.

4. Recognizing the correctness of the preceding conclusion, it is evident that the most serious attention ought to be bestowed on collecting and preserving the manurial refuse obtained in connection with the production of milk; for it depends largely on a judicious management of that matter, how much of the stated manurial value will be actually secured. The liability of a loss in the manurial value of the refuse matter renders it advisable, for financial reasons, not to depend on too close a margin of cash returns.

5. Although it will be conceded that the dairy cow, aside from the special service, is a most important factor in mixed farm management, as far as an economical disposition of home-raised fodder crops and a liberal production of home-made manure are concerned, yet, when reduced to a mere manure-producing medium, this value may be well questioned from a financial stand-point.

6. A cow whose total milk record averages not more than from seven to eight quarts per day, judging from our own conditions, promises to prove a better investment when prepared for the meat market than when constituting a liberal proportion of the stock kept for supplying the general milk market at stated prices.

#### IV. CREAMERY RECORD OF THE STATION DURING THE YEARS 1887, 1888 AND 1889; AND SOME OBSERVATIONS MADE DURING VISITS TO THE PATRONS OF TWO CREAMERIES IN OUR VICINITY.

In preceding pages has been stated the financial record of twelve cows, grades which had served during past years for feeding experiments at the station. It was stated in that connection that the primary object at that time was to test the comparative merits of corn fodder, corn stover, corn ensilage and root crops, in the whole or in part, as circumstances advised, as substitutes for a good meadow hay, as far as quantity, quality and cost of production of milk are concerned. The cows selected for that investigation, were, for stated reasons, of moderate milking qualities. Our financial records, although obtained under somewhat exceptional circumstances, are published with full recognition of that point, considering them not without some interest to others studying the financial side of the dairy industry in its varying aspects.

The subsequent communication contains a discussion of our creamery record, which covers, to a considerable extent, the time when the above-mentioned milk record was obtained. The milk was weighed at the station, and the cream secured and measured by means of a Cooley creamery apparatus. A copy of the daily record was kept in our dairy room by the agent of the creamery. Two quarts of milk used daily for family purposes are accounted for in our calculations of total results. Analyses of milk were made where a change of daily diet rendered it advisable.

The cost of feed consumed is based on the same market price of the various ingredients as was adopted in the preceding milk record. The same is true in regard to the valuation of the whole milk, — three cents per quart. The estimates of the value of fertilizing ingredients contained in the feed are also based upon those given in connection with the preceding milk record.

The value of cream is that granted us from month to month by our local creamery association. The station has

no other connection with the financial management of the creamery.

Our presentation of financial results is based on the local cost of feed alone, and does not consider interest on investment and labor involved; for the reason that approximate estimates on these points are in an exceptional degree dependent on quality of stock, and varying local circumstances. The details are embodied in a few subsequent tables under the following headings:—

1. Statement of articles of fodder used.
2. Record of average quality of milk and of fodder rations.
3. Value of cream produced at creamery basis of valuation.
4. Cost of skim-milk at the selling price of three cents per quart of whole milk.
5. Fertilizing constituents of cream.
6. Some conclusions suggested by the records.



1. STATEMENT OF ARTICLES OF FODDER USED DURING 1887, 1888 AND 1889 (IN POUNDS)—*Concluded.*

	Corn Meal.	Corn and Cob Meal.	Wheat Bran.	Rye Middings.	Gluten Meal.	Hay.	Rowen.	Corn Fodder (Dry).	Corn Stover (Dry).	Corn Ensilage.	Vetch and Oats.	Serradella.	Cow-pea.	Potatoes.	Carrots.	Sugar Beets.
June, .	-	585.0	585.0	-	291.0	3,600.0	-	-	-	-	-	-	-	-	-	-
July, .	413.0	117.0	530.0	-	530.0	2,054.0	-	-	-	-	4,730.5	-	-	-	-	-
August, .	504.0	-	504.0	-	504.0	620.0	2,534.0	-	-	-	-	-	-	-	-	-
September, .	510.0	-	510.0	-	510.0	2,148.5	-	-	-	-	-	-	3,970.0	-	-	-
October, .	575.5	-	575.5	-	575.5	3,431.0	-	-	-	-	-	-	-	-	-	-
November, .	585.0	-	585.0	-	585.0	1,845.0	-	1,318.5	-	-	-	-	-	-	-	-
December, .	588.5	-	588.5	-	588.5	223.0	-	1,183.0	1,488.5	-	-	-	-	-	461.0	-
1889.																
January, .	608.75	-	604.75	-	584.75	1,772.00	-	-	-	1,475.00	-	-	-	-	4,868.00	-
February, .	552.50	-	552.50	-	552.50	1,268.50	-	-	-	5,069.50	-	-	-	-	-	4,081.00
March, .	591.50	-	591.50	-	591.50	2,396.00	-	-	-	-	-	-	-	-	-	1,125.00
April, .	572.00	-	562.25	-	563.88	2,395.50	838.00	-	-	-	-	-	-	-	-	-
May, .	604.50	-	583.38	-	604.50	900.50	2,713.50	-	-	-	-	-	-	-	-	-
June, .	585.00	-	585.00	-	585.00	1,295.50	1,871.00	-	-	-	582.75	-	-	-	-	-
July, .	604.50	-	604.50	-	604.50	434.00	1,871.00	-	-	-	4,308.75	-	-	-	-	-
August, .	402.00	-	402.00	-	402.00	180.00	3,755.25	-	-	-	-	-	-	-	-	-
September, .	585.00	-	585.00	-	585.00	1,002.00	-	-	-	-	-	-	1,512.00	-	-	-
October, .	604.50	-	604.50	-	604.50	3,574.50	-	-	-	-	-	8,182.50	4,983.00	-	-	-



## 2. (B) RECORD OF AVERAGE QUALITY OF MILK AND OF FODDER RATIONS (1888).

1888.	Average Percentage of Bolids in Milk.	Average Percentage of Fat in Milk.	Quarts of Milk required to make One Space of Cream.	Nutritive Ratio of Feed.	Feed consumed per Day (in Pounds).													
					Corn Meal.	Corn and Cob Meal.	Wheat Bran.	Rye Middlings.	Gluten Meal.	Hay.	Rowen.	Corn Fodder (Dry).	Corn Glover (Dry).	Corn Ensilage.	Vetch and Oats.	Berradella.	Cow-pod.	Sugar Beets.
January, .	13.18	4.08	1.58	1:6.1	3.25	-	3.25	3.25	3.25	19.00	-	-	-	-	-	-	-	
February, .	13.98	3.67	1.75	1:6.2	3.25	-	3.25	3.25	3.25	19.00	-	-	-	-	-	-	-	
March, .	13.77	3.79	1.71	1:6.5	3.25	3.25	3.25	3.25	3.25	7.50	-	-	-	-	-	-	-	
April, .	13.83	4.00	1.73	1:6.2	3.25	3.25	3.25	3.25	3.25	20.00	-	-	-	-	-	-	-	
May, .	-	-	1.67	1:5.9	3.25	3.25	3.25	3.25	3.25	20.00	-	-	-	-	-	-	-	
June, .	-	-	1.76	1:7.3	3.25	3.25	3.25	3.25	1.50	20.00	-	-	-	-	-	-	-	
July, .	13.04	3.14	1.93	1:5.5	3.25	3.25	3.25	3.25	3.25	6.00	-	-	-	-	-	-	-	
August, .	12.87	3.86	1.83	1:6.9	3.25	3.25	3.25	3.25	3.25	19.00	-	-	-	-	-	-	-	
September, .	13.26	3.79	1.85	1:6.1	3.25	3.25	3.25	3.25	3.25	19.00	-	-	-	-	-	-	-	
October, .	-	-	1.72	1:4.5	3.25	3.25	3.25	3.25	3.25	5.00	-	-	-	-	-	-	-	
November, .	14.39	4.55	1.63	1:6.3	3.25	3.25	3.25	3.25	3.25	20.00	-	-	-	-	-	-	-	
December, .	14.78	4.86	1.43	1:6.2	3.25	3.25	3.25	3.25	3.25	20.00	-	-	-	-	-	-	-	
Averages,	13.68	3.97	1.72	1:6.7	3.25	3.25	3.25	3.25	3.25	20.00	-	-	-	-	-	-	-	





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## 3. VALUE OF CREAM PRODUCED AT CREAMERY BASIS OF VALUATION.

	Total Cost of Feed consumed.	Total Value of Fertilizing Constituents of Food consumed.	Value of Fertilizing Constituents lost in Cream.	Net Cost of Feed for Production of Cream.	Value of Cream produced.
<b>1887.</b>					
January, . . . .	\$16 21	\$9 69	\$0 27	\$6 79	\$17 24
February, . . . .	40 39	17 76	69	23 32	38 85
March, . . . .	46 93	27 10	71	20 54	40 20
April, . . . .	46 34	22 68	57	24 23	31 14
May, . . . .	36 02	15 34	64	21 32	32 47
June, . . . .	37 57	16 87	66	21 36	30 03
July, . . . .	36 42	16 93	59	20 08	27 69
August, . . . .	41 09	14 94	68	26 83	35 91
September, . . . .	45 48	22 54	69	23 63	36 30
October, . . . .	46 21	20 66	64	26 19	36 30
November, . . . .	47 97	27 02	52	21 47	29 48
December, . . . .	47 01	25 08	60	22 53	35 23
Averages, . . . .	\$10 60	\$19 72	\$0 61	\$21 52	\$32 57
<b>1888.</b>					
January, . . . .	\$43 53	\$21 42	\$0 76	\$22 87	\$45 76
February, . . . .	32 51	20 03	73	13 19	44 00
March, . . . .	33 44	20 03	69	16 08	40 91
April, . . . .	31 71	19 19	65	13 17	35 99
May, . . . .	47 06	22 63	65	25 08	34 23
June, . . . .	42 69	20 11	58	23 16	28 67
July, . . . .	39 66	20 63	63	19 66	30 94
August, . . . .	40 66	23 64	61	17 63	32 48
September, . . . .	39 57	21 42	57	18 72	32 02
October, . . . .	45 15	22 44	62	23 33	35 92
November, . . . .	36 95	21 03	64	16 56	37 67
December, . . . .	29 82	17 97	59	12 44	34 67
Averages, . . . .	\$38 73	\$20 88	\$0 64	\$18 49	\$36 11
<b>1889.</b>					
January, . . . .	\$52 21	\$21 23	\$0 66	\$31 64	\$40 60
February, . . . .	33 83	19 15	63	15 34	36 19
March, . . . .	48 14	21 77	75	27 11	42 48
April, . . . .	46 17	23 40	78	23 55	42 84
May, . . . .	47 28	27 23	83	20 88	39 28
June, . . . .	44 21	23 98	72	20 95	33 06
July, . . . .	43 63	25 28	76	19 11	34 92
August, . . . .	45 44	27 54	76	18 66	36 33
September, . . . .	48 01	28 08	73	20 66	38 25
October, . . . .	37 21	23 47	71	14 45	39 06
Averages, . . . .	\$44 62	\$24 11	\$0 73	\$21 24	\$38 31

#### 4. COST OF SKIM-MILK AT THE SELLING PRICE OF THREE CENTS PER QUART FOR WHOLE MILK.

	Quarts of Milk produced.	Spaces of Cream.	Quarts of Cream (One Quart equals 3.4 Spaces).	Quarts of Skim-milk.	Value of Cream per Space (Cents).	Value of Cream per Quart of Milk (Cents).	Total Value of Cream.	Cost of Skim-milk per Quart (Whole Milk at Three Cents per Quart).	Total Cost of Skim-milk.
<b>1887.</b>								Cents.	
January, .	976.2	445	130.9	845.3	3.88	1.76	\$17 24	1.43	\$12 06
February, .	2,093.1	1,036	304.7	1,788.4	3.75	1.86	38 85	1.34	23 94
March, .	2,352.7	1,072	315.3	2,037.4	3.75	1.71	40 20	1.43	30 38
April, .	2,083.4	859	252.6	1,830.8	3.63	1.50	31 14	1.71	31 36
May, .	1,729.0	922	282.9	1,446.1	3.33	1.38	32 47	1.34	19 40
June, .	1,818.7	1,001	294.4	1,524.3	3.00	1.65	30 03	1.61	24 53
July, .	1,749.7	886	260.6	1,489.1	3.13	1.58	27 69	1.67	24 80
August, .	1,772.6	1,026	301.8	1,470.8	3.50	2.03	35 91	1.17	17 27
September, .	1,808.4	1,037	305.0	1,503.4	3.50	2.01	36 30	1.19	17 95
October, .	1,574.4	968	284.7	1,289.7	3.75	2.31	36 30	0.85	10 93
November, .	1,545.6	786	231.2	1,314.4	3.75	1.91	29 48	1.28	16 89
December, .	1,522.3	909	267.3	1,255.0	3.88	2.31	35 23	0.83	10 44
Averages, .	1,752.2	916	269.3	1,482.9	3.58	1.89	\$32 57	1.32	\$19 99
<b>1888.</b>									
January, .	1,807.5	1,144	336.5	1,471.0	4.00	2.53	\$45 76	0.58	\$8 47
February, .	1,925.8	1,100	323.5	1,602.3	4.00	2.28	44 00	0.86	13 77
March, .	1,794.5	1,049	306.5	1,486.0	3.90	2.28	40 91	0.87	12 98
April, .	1,702.5	966	290.0	1,412.5	3.65	2.11	35 99	1.07	15 09
May, .	1,638.1	978	287.6	1,350.5	3.50	2.10	34 23	1.10	14 91
June, .	1,563.9	832	259.4	1,294.5	3.25	1.85	28 67	1.39	17 95
July, .	1,841.5	952	280.0	1,561.5	3.25	1.68	30 94	1.56	24 31
August, .	1,696.9	928	272.9	1,424.0	3.50	1.91	32 48	1.29	18 43
September, .	1,580.1	854	251.2	1,328.9	3.75	2.03	32 02	1.16	15 38
October, .	1,606.8	938	274.4	1,332.4	3.85	2.24	35 92	1.00	12 28
November, .	1,576.0	966	284.1	1,291.9	4.00	2.39	37 67	0.74	9 61
December, .	1,270.3	889	261.5	1,008.8	4.00	2.73	34 67	0.34	3 44
Averages, .	1,666.2	972	285.8	1,380.4	3.72	2.18	\$36 11	1.00	\$13 88
<b>1889.</b>									
January, .	1,791.1	1,015	298.5	1,492.6	4.00	2.27	\$40 60	0.88	\$13 13
February, .	1,680.0	965	283.8	1,396.2	3.75	2.15	36 19	1.02	14 21
March, .	1,895.0	1,148	337.6	1,557.4	3.70	2.24	42 48	0.92	14 37
April, .	1,931.6	1,190	350.0	1,581.6	3.60	2.22	42 84	0.96	15 11
May, .	2,025.2	1,267	372.6	1,652.6	3.10	1.94	39 28	1.30	21 48
June, .	1,785.6	1,102	324.1	1,461.5	3.00	1.85	33 06	1.40	20 51
July, .	2,001.2	1,164	342.4	1,658.8	3.00	1.74	34 96	1.51	25 12
August, .	1,991.9	1,172	344.7	1,647.2	3.10	1.82	36 33	1.42	23 43
September, .	1,856.0	1,125	330.9	1,525.1	3.40	2.06	38 25	1.14	17 43
October, .	1,665.0	1,065	319.1	1,345.9	3.60	2.35	39 06	0.81	10 89
Averages, .	1,862.3	1,123	330.4	1,531.9	3.43	2.06	\$38 31	1.14	\$17 57

## 5. FERTILIZING CONSTITUENTS OF CREAM.

[Average analysis.]										Per Cent.
Moisture at 100° C.,	.	.	.	.	.	.	.	.	.	75.22
Nitrogen (16½ cents per pound),	.	.	.	.	.	.	.	.	.	.54
Potassium oxide (4½ cents per pound),	.	.	.	.	.	.	.	.	.	.123
Phosphoric acid (6 cents per pound),	.	.	.	.	.	.	.	.	.	.168

## 6. SOME CONCLUSIONS DRAWN FROM THE PRECEDING RECORDS.

1. The relative proportion of digestible nitrogenous and non-nitrogenous constituents consumed differs on the whole in a larger degree during the year 1887 than in 1888. During one-half of the year 1887 it ranged above 1 : 8.5 ; during the year 1888 it reached 1 : 7.3 in only one case, and for six of the remaining months it was below 1 : 6 (nutritive ratio). In 1889 it was in one case only 1 : 6.59, while in all others it resembled quite closely those of the preceding year. The different nutritive ratios averaged, for the year 1887, 1 : 7.08 ; for the year 1888, 1 : 6.00 ; for the year 1889, 1 : 5.80.

2. The amount of fat in the milk varied, during the year 1887, from 3.45 to 4.50 per cent., with an average of 4.00 per cent. ; during the year 1888 it varied from 3.14 to 4.86 per cent., with an average of 3.97 per cent. ; while during the year 1889 it varied from 3.90 to 4.72 per cent., with an average of 4.37 per cent.

3. The quantity of milk, in quarts, required to produce one space of cream, during the year 1887, varied from 2.42 to 1.63, and amounted, on the average, to 1.93 quarts for the entire year ; during the year 1888 it varied from 1.93 to 1.43, averaging for the year 1.72 quarts ; and during the year 1889 it varied from 1.76 to 1.53 quarts, with an average of 1.66 quarts.

4. The value received for one space of cream during the year 1887 varied from 3.00 to 3.88 cents, with an average of 3.58 cents ; during the year 1888 from 3.25 to 4.00 cents were received for each space, with an average of 3.72 cents ; which would equal 12.17 cents per quart of cream for 1887 and 12.65 cents for 1888. During the year 1889 the money value allowed by the creamery for one space of cream varied from 3.00 to 4.00 cents, with an average of 3.43 cents, or 11.66 cents per quart.

• 5. The total cost of feed consumed for the production of one quart of cream amounted for the year 1887 to 15.09 cents, for the year 1888 to 13.55 cents, and for the year 1889 the same as in 1888.

6. The value of fertilizing constituents which are lost to the farm by the sale of cream produced, amounted, according to the analyses of our cream, during the year 1887 to 3.09 per cent., during 1888 to 3.65 per cent., and in 1889 to 3.03 per cent., of the total fertilizing value of the feed. From these figures it will be seen that in selling the cream from the farm much less fertilizing constituents are lost to the farm than in selling the whole milk. A loss of twenty per cent. of the fertilizing constituents contained in the feed has been allowed in our previous publications, when selling the whole milk. The statement of net cost of feed, as compared with that of its total cost, refers to the original cost of the feed less the value of fertilizing constituents obtainable in manure.

7. The net cost of feed consumed per quart of cream (1 quart = 3.4 spaces) averaged, for the year 1887, 8 cents; for the year 1888, 6.47 cents, and for the year 1889, 6.4 cents. As we obtained 12.17 cents per quart of cream during 1887, 12.65 cents during 1888, and 11.5 cents in 1889, we secured a profit above net cost of feed of 4.17 cents per quart in 1887; in the year 1888, 6.18 cents; and in 1889, 5.1 cents, for the same quantity.

8. We produced, during the year 1887, 1,752.2 quarts of whole milk per month; during the year 1888, 1,662.2 quarts; and in 1889, 1,862.3 quarts. It required, on an average, 6.51 quarts of whole milk to produce one quart of cream during 1887, 5.83 quarts during 1888, and 5.64 quarts during 1889. We secured, on an average per month during 1887, 1,482.9 quarts of skim-milk and 269.3 quarts of cream; in 1888, 1,380.4 quarts of skim-milk and 285.8 quarts of cream; and in 1889, 1,531.9 quarts of skim-milk and 330.4 quarts of cream.

9. Counting the whole milk at three cents per quart, then skim-milk has cost us, on an average, during the year 1887, 1.32 cents per quart; during the year 1888, 1.00 cent per quart; and in 1889, 1.14 cents per quart. The cost of

skim-milk varied considerably during different months of the year, mainly on account of the changes in the valuation of the cream. During 1887, the cost of skim-milk varied from .83 to 1.71 cents per quart; in 1888, from .34 to 1.56 cents per quart; and in 1889, from .81 to 1.51 cents per quart.

The feeding value of skim-milk containing 9.5 per cent. of solids, is stated by good authority to stand in the relation of 3.1 to 4, when compared in that respect with whole milk. In case an average whole milk is charged at three cents per quart, skim-milk would be worth, on the previously stated basis, 2.33 cents. The feeding value of skim-milk, estimated on the customary basis of 4.33 cents per pound of digestible nitrogenous substances and of fat, and .9 cents for non-nitrogenous substances, would amount, per gallon, to 1.91 cents.

We have bought, during the past years, creamery butter-milk containing from 7 to 8 per cent. of solids, at 1.37 cents per gallon. (See third annual report, page 42.) Our own skim-milk, with 9.5 per cent. of solids, would represent, on this basis, a value of 1.75 cents per gallon, or .44 cents per quart.

### *Some Facts concerning Two Creameries.*

It seemed of interest to us to learn from personal observation some facts concerning the supply of cream to some creameries in our vicinity. By the courtesy of the officers in charge of these establishments, Mr. Edward R. Flint, assistant in the chemical department of the station, has been permitted to accompany the collectors of cream at their round trips, and to take notes as directed. He has visited at different times all the patrons of these creameries, in all, 193 farms. Cream and butter have been repeatedly tested. The results of our work in this connection are embodied in a few subsequent pages.

### *Creamery A.*

This creamery receives 350 gallons of cream per day, from 129 farms. This is set for sixteen hours at a temperature of 64 degrees F., together with a small amount of sour cream to hasten the ripening process. The cream is then

churned for one hour at a temperature of 64 degrees F., and washed twice with clear water. It is worked once, at which time it is salted at the rate of one ounce of salt per pound. The product of this creamery is about 4,200 pounds per week; 6.13 spaces of cream are considered to make a pound of butter.

*Creamery B.*

This creamery receives 200 gallons of cream per day, from 64 farms. This is set in one vat for twenty-four hours, at a temperature of 60 degrees F. It is then churned for one hour at 65 degrees F., and washed twice in the churn with clear water. It is worked twice, 1½ ounces of salt per pound being added when first worked. This creamery produces 1,850 pounds of butter per week. A little less than six spaces are considered to make a pound of butter.

Butter samples from creameries A and B show the following results of analysis:—

*Creamery A.*

Collected.		Moisture.	Butter Fat.	Casein.	Salt.
		Per Cent.	Per Cent.	Per Cent.	Per Cent.
September	6, . . .	12.35	81.54	.80	5.13
	10, . . .	11.73	81.43	.70	6.45
	16, . . .	12.68	81.65	.71	4.93
	18, . . .	11.02	83.32	.51	3.97
	21, . . .	11.04	81.79	.60	4.55
	23, . . .	10.54	84.35	.54	4.04
	25, . . .	12.31	82.40	.52	5.04
	26, . . .	12.95	82.21	.60	4.63
October	28, . . .	12.52	82.62	.58	4.28
	29, . . .	12.78	87.37	.55	Trace.
	30, . . .	11.48	83.69	.64	4.30
	31, . . .	11.76	82.17	.88	4.45
	Average, . . .	11.93	82.88	.64	4.31

*Creamery B.*

Collected.	Moisture.	Butter Fat.	Casein.	Salt.
<b>1899.</b>	Per Cent.	Per Cent.	Per Cent.	Per Cent.
September 27, . . .	10.77	84.09	.64	5.92
30, . . .	11.00	84.25	.56	5.60
October 1, . . .	9.88	83.15	.56	4.76
3, . . .	7.43	86.64	.58	4.53
17, . . .	9.22	85.00	.75	5.11
18, . . .	9.51	84.10	.62	5.32
21, . . .	11.90	84.00	.89	4.15
22, . . .	10.37	84.01	.68	3.61
November 1, . . .	9.21	86.33	.70	4.12
4, . . .	10.12	86.74	.72	5.90
5, . . .	10.14	83.51	.70	5.63
7, . . .	7.11	89.05	.62	3.96
Average, . . .	9.64	85.07	.66	4.72

Cream samples from creameries A and B show the following results of analysis:—

*Creamery A.*

Collected.	Solids.	Fat.	Solids not Fat.
<b>1899.</b>	Per Cent.	Per Cent.	Per Cent.
September 6, . . .	24.34	16.86	7.48
10, . . .	23.75	16.69	7.06
16, . . .	24.25	17.15	7.10
18, . . .	23.68	16.39	7.29
21, . . .	23.66	15.86	7.80
23, . . .	24.58	18.53	6.05
25, . . .	24.91	13.74	11.17
26, . . .	23.54	15.72	7.82
October 26, . . .	23.38	16.51	6.87
29, . . .	25.17	18.70	6.47
30, . . .	24.96	17.38	7.58
November 6, . . .	24.44	18.23	6.21
8, . . .	24.60	16.94	7.66
December 10, . . .	23.73	15.95	7.78
13, . . .	24.91	16.75	8.16
14, . . .	24.04	15.73	8.31
26, . . .	24.87	16.24	8.63
27, . . .	23.81	15.58	8.23
Average, . . .	24.26	16.61	7.65

*Creamery B.*

Collected.	Solids.	Fat.	Solids not Fat.
<b>1889.</b>	<b>Per Cent.</b>	<b>Per Cent.</b>	<b>Per Cent.</b>
September 27, . . . .	22.65	15.80	6.85
30, . . . .	24.37	16.77	7.60
October 1, . . . .	22.89	15.67	7.22
3, . . . .	23.24	16.05	7.19
17, . . . .	23.58	16.54	7.04
18, . . . .	23.50	16.24	7.26
21, . . . .	23.91	16.98	6.93
22, . . . .	22.82	16.06	6.76
November 1, . . . .	22.81	15.26	7.43
4, . . . .	23.24	15.81	7.52
5, . . . .	23.80	16.28	7.53
7, . . . .	24.72	17.40	7.32
December 12, . . . .	23.38	15.08	8.30
<b>Average, . . . .</b>	<b>23.45</b>	<b>16.13</b>	<b>7.30</b>

*Analyses of Cream from the station dairy, from samples collected during the time of collection from the creameries, the grain feed consisting of three and one-quarter pounds corn meal, three and one-quarter pounds bran, and three and one-quarter pounds gluten meal; the coarse feed of five pounds hay, seventy-five pounds serradella (green).*

Collected.	Solids.	Fat.	Solids not Fat.
<b>1889.</b>	<b>Per Cent.</b>	<b>Per Cent.</b>	<b>Per Cent.</b>
September 6, . . . .	28.09	20.33	7.76
11, . . . .	24.65	17.91	6.74
17, . . . .	25.25	18.95	6.30
18, . . . .	27.65	20.42	7.23
21, . . . .	27.20	20.51	6.69
24, . . . .	27.27	20.16	7.11
25, . . . .	26.21	18.32	7.89
26, . . . .	26.18	17.13	9.05
<b>Average, . . . .</b>	<b>26.56</b>	<b>19.22</b>	<b>7.34</b>



*Summary of Butter and Cream Analyses.**Butter.*

	Moisture.	Butter Fat.	Casein.	Salt.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Average of Creamery A, .	11.93	82.88	.64	4.31
Average of Creamery B, .	9.64	85.07	.66	4.72

*Cream.*

	Solids.	Fat.	Solids not Fat.
	Per Cent.	Per Cent.	Per Cent.
Average of Creamery A, .	24.26	16.61	7.65
Average of Creamery B, .	23.45	16.13	7.30
Average of Station Dairy, .	26.56	19.22	7.34

## Details of Farms contributing to Creamery A

GRAIN FEED.																							
FARM NUMBER.		NUMBER OF COWS.		SPACES OF CREAM.		SPACES FOR COW.		Average Age of Cows.		BREED.		COARSE FEED.		November.		December.		Less than 8 mos.		8 mos. to 9 mos.		More than 9 mos.	
		November.		December.		November.		December.															
1	4	-	17	-	4.00	-	5½	Three pure, one grade Jersey.	Hay, corn fodder, pumpkins.	None.	.	.	.	.	.	.	.	-	1	2	1		
2	13	13	20	43	2.92	3.69	4	Pure and grade Jersey.	Rowen, hay, corn stalks.	4 qts. cob meal and rye.	Same.	.	.	.	.	.	.	-	6	6			
3	5	5	28	20	4	4	4½	Jersey and native.	Pasture (Nov.), rowen, stover.	None.	4 qts. meal and bran.	.	.	.	.	.	.	1	3	2			
4	5	5	10	13	2	2.60	4	Grade Jersey.	Hay, corn fodder.	4 qts. bran.	Same.	.	.	.	.	.	.	2	6	-			
5	11	10	45	32	4.09	3.20	7	Pure and grade Jersey, Holstein, native.	Pasture (Nov.), hay.	None.	4 qts. bran.	.	.	.	.	.	.	-	5	-			
6	2	6	10	21	5	3.50	7½	Grade Jersey.	Pasture (Nov.), soft corn, hay.	None.	4 qts. meal and bran.	.	.	.	.	.	.	4	2	-			
7	5	6	13	29	2.60	4.83	6	Grade Durham.	Hay, corn fodder.	Meal and bran.	8 qts. cob meal and bran.	.	.	.	.	.	.	5	1	-			
8	18	20	59	77	3.23	3.85	5	Grade Jersey, Holstein, Durham, Guernsey.	Hay, corn fodder.	4 qts. meal and bran.	Same, with 1 qt. linseed.	.	.	.	.	.	.	11	6	3			
9	9	4	21	9	2.33	2.25	6½	Grade Jersey, Guernsey, native.	Rowen, corn stover.	4 qts. cob meal and rye.	Same.	.	.	.	.	.	.	-	-	9			
10	4	4	17	14	4.25	3.50	5	Grade Jersey.	Hay, sugar beets.	4 qts. meal and bran.	Same.	.	.	.	.	.	.	1	3	-			
11	9	12	31	55	3.33	4.51	7	Grade Jersey, Durham, native.	Pasture (Nov.), rowen, hay.	2 qts. meal.	4 qts. bran, cotton seed, corn.	.	.	.	.	.	.	9	3	-			
12	12	12	36	37	3	3.08	6½	Grade Durham.	Hay, corn fodder.	4 qts. cob meal.	5 qts. meal and bran.	.	.	.	.	.	.	1	6	5			
13	15	17	48	52	3.20	3.06	6½	Grade Jersey, Holstein, native.	Hay, corn fodder.	5 qts. meal, bran, rye.	Same, with broom seed.	.	.	.	.	.	.	3	4	10			

*Details of Farms contributing to Creamery A—Continued.*

Farm Number.	Number of Cows.		Spaces of Cream.		Average Age of Cows.		Breed.	Coarse Feed.	Grain Feed.		Number of Months since Last Calf.		
	November.	December.	November.	December.	November.	December.			November.	December.	Less than 3 mos.	3 mos. to 9 mos.	More than 9 mos.
14	6	7	17	1	3.40	—	Grade Durham.	Hay, corn fodder,	Same.	Same.	2	6	—
15	24	24	86	82	3.58	3.41	Grade Jersey, Holstein, native,	Rowen, corn fodder,	2 qts. bran, 4 qts. cob meal,	Same.	—	24	—
16	3	—	14	16	4.67	—	Grade Durham, Ho'stein,	Pasture (Nov.), hay,	—	—	2	1	—
17	6	6	25	23	4.17	3.83	Grade Jersey, Durham, Holstein,	Hay, corn fodder,	5 qts. meal and bran,	Same.	—	3	3
18	10	10	47	18	4.70	1.90	Grade Durham.	Hay, corn fodder,	None.	None.	1	9	—
19	3	4	20	19	6.67	4.75	Grade Jersey and Ayrshire,	Pasture (Nov.) hay,	2 qts. meal and bran,	Same.	3	1	—
20	4	4	12	19	3	4.75	Grade Jersey, Holstein, native,	Pasture (Nov.), rowen, hay,	None.	6 qts. bran,	2	2	—
21	4	12	17	39	4.23	3.25	Grade Durham, Holstein,	Rowen, hay,	2 qts. bran,	8 qts. meal and bran,	2	7	3
22	8	8	23	27	4.13	3.38	Grade Durham, Holstein,	Pasture, soft corn (Nov.), hay,	None.	4 qts. meal,	—	4	4
23	4	4	20	16	5	4	Grade Jersey, native, Durham,	Pasture, soft corn (Nov.), hay, corn fodder,	None.	6 qts. cob meal,	1	2	1
24	9	9	30	31	3.34	3.44	Native and grade Jersey.	Pumpkins (Nov.), hay, corn fodder,	4 qts. cob meal and bran,	8 qts. cob meal and bran,	—	6	4
25	3	6	18	24	6	6.67	Pure and grade Jersey,	Hay, corn fodder,	7 qts. cob meal and bran,	Same.	6	1	—

30	7	7	23	20	3.29	2.80	7	Pure Jersey,	Pasture (Nov.), hay, corn fodder,	None,	.	.	.	4 qts. cob meal and bran,	2	1	4
31	4	4	27	20	6.75	5	6	Grade Jersey, native,	Pasture (Nov.), hay, corn fodder,	4 qts. corn, oats, bran,	.	.	.	Same,	4	-	-
32	4	4	11	-	2.76	-	8	Grade Jersey, native,	Pasture (Nov.), hay, corn fodder,	4 qts. meal and bran,	.	.	.	Same,	-	-	-
33	3	3	8	-	2.57	-	9	Grade Durham, Holstein, Jersey,	Pasture (Nov.), hay,	None,	.	.	.	None,	-	-	-
34	3	3	18	3	4.33	6	6	Pure and grade Jersey,	Pasture (Nov.), hay, corn fodder,	None,	.	.	.	4 qts. meal and bran,	1	1	1
35	10	11	29	38	2.90	2.80	4	Grade Jersey, Durham,	Pasture (Nov.), hay, corn fodder,	None,	.	.	.	None,	1	9	-
36	11	11	31	20	2.82	1.81	5 1/2	Grade Jersey, Durham, Holstein,	Pasture (Nov.), hay, corn fodder,	None,	.	.	.	4 qts. cob meal and rye,	6	5	-
37	7	7	38	40	5.43	6.57	6	Grade Durham, Holstein,	Hay, corn fodder,	4 qts. clear meal,	.	.	.	Same,	2	8	-
38	40	40	123	108	3.08	2.70	7 1/2	Grade Durham, Holstein,	Hay, corn fodder,	4 qts. meal and bran,	.	.	.	Same,	1	35	4
39	4	4	13	14	3.25	3.50	6 1/2	Grade Durham,	Hay, corn fodder,	4 qts. meal, oats and bran,	.	.	.	Same,	1	2	-
40	14	18	39	45	2.79	2.50	6 1/2	Grade Jersey, Durham, Holstein,	Pasture (Nov.), hay, corn fodder,	None,	.	.	.	4 qts. meal and bran,	3	18	-
41	7	11	35	33	5	3	7	Grade Durham,	Rowen, corn fodder,	None,	.	.	.	4 qts. cob meal and bran,	1	10	-
42	16	15	65	51	4.06	3.40	5	Grade Durham, Holstein,	Rowen, corn fodder,	2 qts. bran,	.	.	.	4 qts. meal, bran, rye,	6	9	-
43	4	4	20	17	5	4.25	7	Native,	Pasture (Nov.), rowen,	3 qts. bran,	.	.	.	Same,	-	-	-
44	12	12	30	34	2.50	2.83	8	Grade Durham,	Rowen, hay, pumpkins (Nov.), corn fodder,	2 qts. malt sprouts,	.	.	.	4 qts. bran,	10	2	-
45	3	6	16	40	5.34	6.67	5	Grade Jersey, native,	Sugar beets, hay, corn fodder,	5 qts. meal and bran,	.	.	.	Same,	3	1	2

Details of Farms contributing to Creamery A—Continued.

FARM NUMBER.	NUMBER OF COWS.		SPACES OF CREAM.		SPACES PER COW.		BREED.	COARSE FEED.	GRAIN FEED.		NUMBER OF MONTHS SINCE LAST CALF.	
	November.	December.	November.	December.	November.	December.			November.	December.	Less than 3 mos.	More than 3 mos.
46	4	4	15	-	3.75	-	Grade Jersey, Durham, Holstein.	Pasture (Nov.), hay, rowen.	4 qts. malt sprouts.	Bran.	1	3
47	16	16	82	45*	5.13	2.81	Grade Jersey, native.	Hay, corn fodder.	4 qts. clear meal.	Same.	8	6
48	4	4	15	17	3.75	4.25	Grade Jersey.	Pasture (Nov.), hay, corn fodder.	None.	Bran and meal.	4	-
49	6	4	22	24	3.67	6	Pure Ayrshire, native, grade Holstein.	Pasture (Nov.), hay, corn fodder.	4 qts. meal and bran.	Same.	2	4
50	6	6	15	25	2.17	4.17	Grade Jersey.	Pasture (Nov.), rowen, corn stover, hay.	None.	4 qts. meal and bran.	2	4
51	6	6	33	31	5.50	4.17	Grade Jersey, Durham, Ayrshire, Holstein.	Hay.	3½ lbs. each, bran, meal and gluten.	Same.	1	5
52	20	20	70	47	3.50	2.35	Pure Jersey, Guernsey, Ayrshire, Holstein.	Hay.	8 qts. bran, oats, cotton seed.	Same.	-	-
53	3	3	12	9	4	3	Grade Jersey, Holstein.	Pasture (Nov.), hay, corn stover.	None.	None.	1	2
54	2	3	5	10	2.50	3.33	High-grade Jersey, Holstein.	Pasture (Nov.), hay, squashes.	None.	6 qts. meal and middlings.	-	3
55	6	6	14	17	2.33	2.83	Grade Jersey.	Pasture (Nov.), hay.	2 qts. meal.	Same.	1	4
56	13	15	22	43	1.66	2.87	Grade Jersey, Durham, Holstein.	Pasture (Nov.), hay, corn stover.	None.	4 qts. meal and bran.	6	8
57	5	9	21	38	4.20	4.22	High-grade Jersey, native.	Pasture (Nov.), hay.	2 qts. meal, oats, bran.	Same.	3	5
58	7	9	37	47	5.29	6.22	Grade Jersey and Guernsey.	Pasture (Nov.), hay.	4 qts. provender.	4 qts. bran.	9	-

64	11	30	23	2.73	2.55	5	Pure and grade Jersey, Holstein, Durham, . . .	Hay, corn fodder, . . .	4 qts. meal, . . .	Same, . . .	4	7
65	6	31	22	6.20	5.50	5	Grade Jersey, . . .	Pasture (Nov.), hay, . . .	2 qts. meal and bran, . . .	Same, . . .	4	-
66	5	25	17	5	3.40	5	Pure and grade Jersey, Holstein, . . .	Pasture (Nov.), hay, . . .	2 qts. meal, . . .	Same, . . .	1	4
67	6	22	23	3.67	3.83	7½	Grade Jersey, Holstein, native, . . .	Pasture (Nov.), hay, corn fodder, . . .	1 qt. meal, 3 qts. bran, . . .	1½ qts. meal, 4 qts. bran, . . .	-	6
68	7	30	-	4.29	-	5	Grade Holstein and Durham, . . .	Pasture (Nov.), rowen, corn stover, . . .	4 qts. meal and bran, . . .	Same, . . .	3	2
69	7	45	34	6.43	4.86	4½	Grade Jersey and Durham, . . .	Pasture (Nov.), hay, . . .	4 qts. meal and bran, . . .	Same, . . .	2	5
70	4	9	6	2.25	1.50	6	Grade Jersey, . . .	Pasture (Nov.), hay, . . .	None, . . .	None, . . .	-	4
71	10	38	43	3.80	4.30	6	Grade Jersey, native, . . .	Pasture (Nov.), hay, corn fodder, . . .	3 qts. meal and bran, . . .	8 qts. meal and bran, . . .	5	5
72	13	44	44	3.38	3.38	5½	Grade Jersey, native, . . .	Hay, corn stover, . . .	5 qts. cob meal and shorts, . . .	Same, . . .	3	6
73	5	13	23	2.60	4.60	6	Grade Jersey, . . .	Pasture (Nov.), hay, corn stover, . . .	4 qts. meal and bran, . . .	Same, . . .	4	1
74	3	3	7	1	2.33	2½	Grade Jersey, Durham, Devon, . . .	Pasture (Nov.), hay, corn fodder, . . .	None, . . .	Bran, . . .	3	-
75	14	-	53	48	3.79	-	Grade Jersey, . . .	Hay, . . .	8 qts. meal and bran, . . .	Same, . . .	-	-
76	4	4	12	12	3	3	High-grade Jersey, grade Durham, . . .	Hay, . . .	6 qts. bran, bakery waste, . . .	Same, . . .	-	-
77	6	6	24	4.33	4	6	Grade Jersey, native, . . .	Hay, rowen, corn fodder, . . .	4 qts. bran, 2 qts. meal, . . .	Same, . . .	-	-

\* Sells milk.

Details of Farms contributing to Creamery A—Continued.

FARM NUMBER.	NUMBER OF COWS.		SPACES PER COW.		Average Age of Cows.		BREED.	COARSE FEED.	GRAIN FEED.		NUMBER OF MONTHS SINCE LAST CALF.	
	November.	December.	November.	December.	November.	December.			November.	December.	Less than 3 mos.	More than 3 mos.
78	12	12	28	27	2.33	2.25	Pure and grade Jersey,	Pasture (Nov.), hay, corn stover,	None,	.	.	.
79	12	12	4*	4*	.33	-	Grade Jersey,	Pasture (Nov.), hay, corn stover,	4 qts. bran and meal,	.	.	.
80	7	6	14	17	2	2.83	Grade Jersey,	Hay,	2 qts. bran,	.	.	7
81	6	6	11	13	1.83	2.17	Grade Jersey and Durham,	Hay, corn stover,	None,	.	2 qts. fine feed,	1
82	4	4	31	26	7.75	6.50	Pure Jersey,	Hay,	.	.	.	4
83	6	6	26	24	4.33	4	Grade Jersey, native,	Hay, corn fodder,	.	.	.	2
84	7	7	20	16	2.86	2.20	Grade Jersey, Durham,	Pasture (Nov.), hay, corn fodder,	2 qts. meal,	.	.	.
85	8	8	24	25	3	3.13	Grade Jersey, Durham,	Hay, corn fodder,	.	.	.	3
86	5	5	20	20	5	5	Pure and grade Jersey, grade Guernsey,	Hay, corn stover,	.	.	.	5
87	7	7	13	-	1.86	-	Grade Jersey,	Hay, corn fodder,	.	.	.	2
88	8	8	21	13	2.63	1.63	Native,	Hay, corn fodder,	.	.	.	3
89	6	6	19	16	3.17	2.67	Native,	Pasture (Nov.), hay, corn fodder,	4 qts. bran,	.	4 qts. bran, 2 qts. meal,	1
90	7	7	13	13	2.43	4.33	Grade Jersey,	Hay, rowen, corn fodder,	.	.	4 qts. bran, rye, corn,	2

96	5	8	23	18	4.60	3.60	5	Grade Jersey, . . . .	Pasture (Nov.), hay, corn fodder,	2 qts. bran,	. . .	4 qts. meal and bran,	. . .	5
97	2	-	6	-	3	-	4½	High-grade Jersey, . . . .	Pasture (Nov.), hay, . . . .	5 qts., ½ rye, ½ corn,	. . .	4 qts. corn and rye,	. . .	10
98	12	12	55	60	4.53	4.17	6	Grade Jersey and Durham,	Pasture (Nov.), hay, . . . .	2 qts. meal, 4 qts. bran,	. . .	Same, . . . .	. . .	12
99	11	11	64	46	4.91	4.18	6	Grade Jersey, Durham, . . . .	Soft corn (Nov.), corn fodder,	None, . . . .	. . .	4 qts. corn and oats,	. . .	1
100	12	12	45	49	3.75	4.08	4	Grade Durham, Holstein, Hereford, Devon, . . . .	rowen, hay, . . . .	3 qts. bran,	. . .	Same, . . . .	. . .	2
101	13	14	77	70	5.92	5	7	Grade Jersey, . . . .	Pasture (Nov.), hay, corn fodder,	4 qts. meal and bran,	. . .	3 qts. meal, 2 qts. shorts,	. . .	1
102	7	9	31	35	4.43	3.89	7	Grade Jersey, Guernsey, Holstein, native, . . . .	Rowen, hay, corn fodder, . . . .	8 qts. meal, bran, middlings,	. . .	4 qts. meal and middlings,	. . .	4
103	5	5	25	23	5	4.60	4½	Grade Jersey, native, . . . .	Hay, corn fodder, . . . .	None, . . . .	. . .	1 qt. meal, . . . .	. . .	3
104	10	10	42	56	4.25	5.60	3½	Grade and pure Guernsey, . . . .	Hay, . . . .	4 qts. meal and middlings,	. . .	Same, . . . .	. . .	3
105	8	8	38	31	4.56	3.88	6½	Pure and grade Jersey, . . . .	Hay, corn stover, . . . .	3 qts. meal,	. . .	Same, . . . .	. . .	8
106	2	6	9	19	4.50	3.17	7½	Pure Jersey and Hereford, . . . .	Hay, corn fodder, . . . .	8 qts. meal and bran,	. . .	Same, . . . .	. . .	6
107	7	-	26	36	3.71	-	5	Grade Jersey, Durham, . . . .	Hay, corn fodder, . . . .	2 qts. meal and bran,	. . .	Same, . . . .	. . .	-
108	5	5	19	20	3.89	4	5	Grade Durham, . . . .	Hay, corn fodder, . . . .	4 qts. meal and bran,	. . .	Same, . . . .	. . .	2
109	4	4	16	15	4	3.75	5	Pure and grade Jersey, . . . .	Hay, corn fodder, . . . .	Meal, . . . .	. . .	Same, . . . .	. . .	2

\* Sella milk.



*Details of Farms contributing to Creamery A—Concluded.*

FARM NUMBER.	NUMBER OF COWS.		SPACES OF CREAM.		SPACES PER COW.		Average Age of Cows.	BREED.	COARSE FEED.	GRAIN FEED.		NUMBER OF MONTHS SINCE LAST CALF.		
	November.	December.	November.	December.	November.	December.				November.	December.	Less than 3 mos.	3 mos. to 8 mos.	More than 8 mos.
110	9	9	21	31	2.33	3.44	5½	Grade Jersey, Holstein, native,	Hay, corn stover,	4 qts. meal and bran,	Same, . . . . .	1	8	-
111	6	12	17	30	2.83	2.50	6	Grade Durham, . . . . .	Hay, corn stover,	Meal and bran, .	Same, . . . . .	-	11	1
112	11	11	26	31	2.36	2.82	6	Grade Jersey, native, . . . .	Hay, corn stover,	6 qts. meal, bran, oats,	Same, . . . . .	-	11	-
113	10	10	27	55	2.70	5.50	3½	Grade Jersey, Ayrshire, . . .	Pasture (Nov.), hay, . . .	None, . . . . .	None, . . . . .	1	9	-
114	4	4	13	10	3.25	2.50	5	Grade Jersey, native, . . . .	Hay, . . . . .	4 qts. meal, . . .	Same, . . . . .	-	4	-
115	5	6	24	32	4.80	5.33	5½	Grade Jersey, Durham, . . .	Rowen, corn stover, . . .	4 qts. meal and bran,	Same, . . . . .	2	4	-
116	2	2	10	14	5	7	6	Grade Jersey, Ayrshire, native,	Rowen, hay, corn stover, .	4 qts. cob meal, .	Same, . . . . .	1	1	-
117	4	4	18	20	4.50	5	5	Grade Jersey, Durham, . . .	Hay, corn stover, . . . .	5½ qts. meal and bran,	7 qts. meal and bran,	1	8	-
118	6	6	24	20	4	3.33	4½	Grade Jersey, Holstein, native,	Hay, . . . . .	3 qts. corn and rye, .	Same, . . . . .	2	4	-
119	13	13	48	40	3.66	3.08	5½	Grade Jersey, Ayrshire, . . .	Hay, corn fodder, . . . .	8 qts. meal and mid- dlings, . . . . .	Same, . . . . .	2	11	-
120	10	-	51	57	5.10	-	4	Grade Jersey, . . . . .	Hay, corn fodder, . . . .	6 qts. meal and bran,	Same, . . . . .	4	6	-
121	13	13	23	29	1.77	2.23	5	Grade Durham, Guernsey, pure Holstein, . . . . .	Pasture (Nov.), hay, corn fodder,	4½ qts. meal and bran,	Same, . . . . .	8	6	4
122	7	10	31	48	4.43	4.80	6	Grade Jersey, Ayrshire, . . .	Pasture (Nov.), hay, corn stover,	3 qts. meal and bran,	4½ qts. cob meal, bran, rye,	4	2	4
123	8	8	19	10	2.38	1.25	7	Grade Jersey, Durham, . . .	Pasture (Nov.), hay, corn fodder,	4 qts. meal, . . .	Same, . . . . .	-	8	-

129	7	7	27	23	3.85	3.29	6	Grade Jersey, Durham, . .	Rowen, corn fodder, . .	4 qts. meal, . .	Same, . . . . .	3	2	2
130	-	6	-	43	-	7.17	5	Grade Jersey, Holstein, . .	Hay, corn fodder, . .	-	4 qts. cob meal, 6 qts. bran, . .	6	1	-
131	-	4	-	11	-	2.75	6	Grade Jersey, . . . . .	Hay, . . . . .	-	2 qts. cob meal and bran, . .	3	1	-

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Details of Farms contributing to Creamery A—Concluded.

FARM NUMBER.	NUMBER OF COWS.		SPACES OF CREAM.		SPACES PER COW.		AVERAGE AGE OF COWS.	BREED.	COARSE FEED.	GRAIN FEED.		NUMBER OF MONTHS SINCE LAST CALF.		
	November.	December.	November.	December.	November.	December.				November.	December.	Less than 3 mos.	3 mos. to 9 mos.	More than 9 mos.
110	9	9	21	31	2.33	3.44	5½	Grade Jersey, Holstein, native,	Hay, corn stover,	4 qts. meal and bran,	Same, . . . . .	1	8	-
111	6	12	17	30	2.83	2.50	6	Grade Durham, . . . .	Hay, corn stover,	Meal and bran, .	Same, . . . . .	-	11	1
112	11	11	26	31	2.36	2.82	6	Grade Jersey, native,	Hay, corn stover,	6 qts. meal, bran, oats,	Same, . . . . .	-	11	-
113	10	10	27	55	2.70	5.50	3½	Grade Jersey, Ayrshire, .	Pasture (Nov.), hay,	None, . . . . .	None, . . . . .	1	9	-
114	4	4	13	10	3.25	2.50	5	Grade Jersey, native,	Hay, . . . . .	4 qts. meal,	Same, . . . . .	-	4	-
115	5	6	24	32	4.80	5.33	5½	Grade Jersey, Durham, .	Rowen, corn stover,	4 qts. meal and bran,	Same, . . . . .	2	4	-
116	2	2	10	14	5	7	6	Grade Jersey, Ayrshire, native,	Rowen, hay, corn stover,	4 qts. cob meal,	Same, . . . . .	1	1	-
117	4	4	18	20	4.50	5	5	Grade Jersey, Durham, .	Hay, corn stover,	5½ qts. meal and bran,	7 qts. meal and bran,	1	3	-
118	6	6	24	20	4	3.33	4½	Grade Jersey, Holstein, native,	Hay, . . . . .	3 qts. corn and rye,	Same, . . . . .	2	4	-
119	13	13	48	40	3.66	3.08	5½	Grade Jersey, Ayrshire, .	Hay, corn fodder,	8 qts. meal and mid- dlings, . . . . .	Same, . . . . .	2	11	-
120	10	-	51	57	5.10	-	4	Grade Jersey, . . . . .	Hay, corn fodder,	6 qts. meal and bran,	Same, . . . . .	4	6	-
121	13	13	23	29	1.77	2.23	5	Grade Durham, Guernsey, pure Holstein, . . . . .	Pasture (Nov.), hay, corn fodder,	4½ qts. meal and bran,	Same, . . . . .	3	6	4
122	7	10	31	48	4.43	4.80	6	Grade Jersey, Ayrshire, .	Pasture (Nov.), hay, corn stover,	3 qts. meal and bran,	4½ qts. cob meal, bran, rye,	4	2	4
123	8	8	19	10	2.38	1.25	7	Grade Jersey, Durham, .	Pasture (Nov.), hay, corn fodder,	4 qts. meal,	Same, . . . . .	-	8	-

17	3	3	19	17	6.33 5.97	4	Pure Jersey and grades, . . .	Rowen, . . . . .	6 qts. meal and bran, . . .	Same, . . . . .	3
18	11	39	34	3.54 3.09	6½	Grade Jersey, native, . . .	Pasture (Nov.), hay, . . .	Pasture (Nov.), hay, . . .	None, . . . . .	4 qts. meal and bran, . .	8
19	14	15	67	4.79 4.33	6	Grade Jersey, Durham, native, . .	Pasture (Nov.), hay, rowen, corn stover, . . . . .	Pasture (Nov.), hay, rowen, corn stover, . . . . .	4 qts. ½ meal, ½ bran, . .	6 qts. ½ meal ½ bran, . .	13
20	4	6	18	4.50 3	6	Grade Jersey, native, . . .	Pasture (Nov.), hay, corn stover, rowen, . . . . .	Pasture (Nov.), hay, corn stover, rowen, . . . . .	None, . . . . .	1½ qts. meal and rye, . .	2
21	22	16	61	33* 2.69 2.06	5	Grade Jersey, . . . . .	Hay, corn fodder (Dec.), . .	Hay, corn fodder (Dec.), . .	4 qts. meal and bran, . . .	Same, . . . . .	5
22	6	7	19	26 3.19 3.71	6	Pure and grade Jersey, . . .	Hay, corn fodder, . . . . .	Hay, corn fodder, . . . . .	4 qts. meal and bran, . . .	Same, . . . . .	3
23	5	4	18	14 3.60 3.50	3	Grade Jersey, Holstein, native, . .	Hay, rowen, corn fodder, . .	Hay, rowen, corn fodder, . .	1 qt. meal, 3 qts. bran, . .	Same, . . . . .	1
24	6	3	10	12 1.60 4	5	Grade Jersey, . . . . .	Pasture (Nov.), hay, corn stover, . .	Pasture (Nov.), hay, corn stover, . .	4 qts. meal and bran, . . .	Same, . . . . .	2
25	17	16	72	74* 4.18 4.62	6	Grade Jersey, Devon, . . .	Rowen, hay, barley, corn stover, . .	Rowen, hay, barley, corn stover, . .	3 qts. meal, 2 qts. bran, . .	Same, . . . . .	6
26	4	5	19	22 4.75 4.40	5	Grade Jersey, Durham, . . .	Pasture (Nov.), hay, corn stover, . .	Pasture (Nov.), hay, corn stover, . .	None, . . . . .	4 qts. cob meal and bran, .	4
27	8	6	21	24 2.62 4	5	Grade Jersey, . . . . .	Pasture (Nov.), rowen, corn stover, . . . . .	Pasture (Nov.), rowen, corn stover, . . . . .	None, . . . . .	2 qts. corn and rye, . .	6
28	10	8	35	31 3.50 3.87	5	Grade Jersey, Durham, . . .	Pasture (Nov.), hay, corn fodder, . .	Pasture (Nov.), hay, corn fodder, . .	3 qts. bran, . . . . .	3 qts. meal and bran, . .	4
29	12	12	26	43 2.17 3.58	4	Grade Jersey, Holstein, Durham, . .	Pasture (Nov.), hay, corn fodder, . .	Pasture (Nov.), hay, corn fodder, . .	None, . . . . .	3 qts. meal and bran, . .	5
30	13	10	42	31 3.23 3.10	5½	Grade Holstein, . . . . .	Hay, corn fodder, . . . . .	Hay, corn fodder, . . . . .	2 qts. cob meal, . . . . .	4 qts. meal and bran, . .	5
31	4	4	11	21 2.75 5.25	4	Grade Jersey, . . . . .	Hay, corn fodder, . . . . .	Hay, corn fodder, . . . . .	2 qts. meal and bran, . . .	Same, . . . . .	2

\* Sells milk.

*Details of Farms contributing to Creamery B.*

FARM NUMBER.	NUMBER OF COWS.		SPACES OF CREAM.		SPACES PER COW.		Average Age of Cows.	BREED.	COARSE FEED.	GRAIN FEED.		NUMBER OF MONTHS SINCE LAST CALF.		
	November.	December.	November.	December.	November.	December.				November.	December.	Less than 3 mos.	3 mos. to 9 mos.	More than 9 mos.
1	3	3	13	12	3.33	4	5	Grade Jersey, . . . .	Rowen, oat straw, . . . .	6 qts. meal and bran, . . . .	Same, . . . .	1	2	-
2	4	4	9	10	2.25	2.50	4	Grade Jersey, Durham, native,	Rowen, hay, . . . .	None, . . . .	None, . . . .	-	-	4
3	6	6	17	14	2.83	2.33	8½	Grade Holstein, native, . . . .	Pasture (Nov.), rowen, . . . .	None, . . . .	None, . . . .	-	3	3
4	14	6	32	22	2.29	3.67	6	Grade Jersey, Durham, Holstein,	Hay, corn fodder, . . . .	2 qts. meal, 4 qts. bran, . . . .	Same, . . . .	2	6	6
5	8	7	20	21	2.50	3	5½	Grade Jersey, . . . .	Pasture (Nov.), rowen, corn stover, . . . .	None, . . . .	None, . . . .	-	6	2
6	11	12	58	47	5.27	3.91	6½	Grade Jersey, . . . .	Pasture (Nov.) hay, . . . .	4 qts. bran, . . . .	4 qts. meal and bran, . . . .	2	3	3
7	9	9	40	43	4.44	4.77	8	Grade Jersey, Durham, Hereford, . . . .	Pasture (Nov.), hay, oats, corn stover, . . . .	Meal and bran, . . . .	2 qts. meal and bran, . . . .	-	5	4
8	11	11	34	32	3.09	2.90	7	Grade Jersey, Durham, . . . .	Pasture (Nov.), hay, corn fodder, . . . .	None, . . . .	6 qts. meal and bran, . . . .	-	4	7
9	5	8	7	22	1.40	2.75	5½	Pure and grade Jersey, grade Durham, . . . .	Pasture (Nov.), hay, potatoes (Nov.), . . . .	4 qts. bran, . . . .	4 qts. meal and bran, . . . .	1	5	2
10	6	6	32	24	5.16	4	4	Grade Jersey, Durham, . . . .	Pasture (Nov.), hay, rowen, . . . .	None, . . . .	2 qts. meal and bran, . . . .	1	3	2
11	4	4	13	9	3.25	2.25	5	Grade Jersey, Ayrshire, . . . .	Pasture (Nov.), hay, . . . .	None, . . . .	2 qts. meal, . . . .	1	2	1

16	4	4	22	21	3.50	5.25	6	Pure and grade Jersey,	.	.	.	.	.	.	.	Meal and bran,	.	.	.	.	Same,	.	.	.	.	3	1
17	3	3	19	17	6.33	5.07	4	Pure Jersey and grades,	.	.	.	.	.	.	.	6 qts. meal and bran,	.	.	.	.	Same,	.	.	.	.	-	3
18	11	11	39	34	3.54	3.09	6½	Grade Jersey, native,	.	.	.	.	.	.	.	None,	.	.	.	.	4 qts. meal and bran,	.	.	.	.	2	8
19	14	15	67	65	4.79	4.33	6	Grade Jersey, Durham, native,	.	.	.	.	.	.	.	4 qts. meal, ½ bran,	.	.	.	.	6 qts. ¾ meal ½ bran,	.	.	.	.	13	1
20	4	6	18	18	4.60	3	6	Grade Jersey, native,	.	.	.	.	.	.	.	None,	.	.	.	.	1½ qts. meal and rye,	.	.	.	.	2	2
21	22	16	61	33*	2.69	2.06	5	Grade Jersey,	.	.	.	.	.	.	.	4 qts. meal and bran,	.	.	.	.	Same,	.	.	.	.	6	9
22	6	7	19	26	3.16	3.71	6	Pure and grade Jersey,	.	.	.	.	.	.	.	4 qts. meal and bran,	.	.	.	.	Same,	.	.	.	.	3	4
23	5	4	18	14	3.60	3.50	3	Grade Jersey, Holstein, native,	.	.	.	.	.	.	.	1 qt. meal, 3 qts. bran,	.	.	.	.	Same,	.	.	.	.	1	3
24	6	3	10	12	1.66	4	5	Grade Jersey,	.	.	.	.	.	.	.	4 qts. meal and bran,	.	.	.	.	Same,	.	.	.	.	-	2
25	17	16	72	74*	4.18	4.62	6	Grade Jersey, Devon,	.	.	.	.	.	.	.	3 qts. meal, 2 qts. bran,	.	.	.	.	Same,	.	.	.	.	6	8
26	4	5	19	22	4.75	4.40	5	Grade Jersey, Durham,	.	.	.	.	.	.	.	None,	.	.	.	.	4 qts. cob meal and bran,	.	.	.	.	4	-
27	8	6	21	24	2.62	4	5	Grade Jersey,	.	.	.	.	.	.	.	None,	.	.	.	.	2 qts. corn and rye,	.	.	.	.	5	1
28	10	8	35	31	3.50	3.87	5	Grade Jersey, Durham,	.	.	.	.	.	.	.	3 qts. bran,	.	.	.	.	3 qts. meal and bran,	.	.	.	.	-	4
29	12	12	26	43	2.17	3.58	4	Grade Jersey, Holstein, Durham,	.	.	.	.	.	.	.	None,	.	.	.	.	3 qts. meal and bran,	.	.	.	.	-	5
30	13	10	42	31	3.23	3.10	5½	Grade Holstein,	.	.	.	.	.	.	.	2 qts. cob meal,	.	.	.	.	4 qts. meal and bran,	.	.	.	.	-	5
31	4	4	11	21	2.75	5.25	4	Grade Jersey,	.	.	.	.	.	.	.	2 qts. meal and bran,	.	.	.	.	Same,	.	.	.	.	2	2

\* Bella milk.

Details of Farms contributing to Creamery B—Concluded.

FARM NUMBER.	NUMBER OF COWS.		SPACES OF CREAM.		SPACES PER COW.		BREED.	COARSE FEED.	GRAIN FEED.		NUMBER OF MONTHS SINCE LAST CALF.		
	November.	December.	November.	December.	November.	December.			November.	December.	Less than 3 mos.	3 mos. to 9 mos.	More than 9 mos.
32	7	7	31	22	4.43	3.14	0	Grade Jersey, Ayrshire, .	Hay, . . . . .	1½ qts. meal, .	Same, . . . . .	-	-
33	4	3	14	14	3.50	4.06	54	Pure and grade Jersey, .	Pasture (Nov.), hay, .	1 qt. meal, .	3 qts. meal, .	3	1
34	2	4	15	26	7.50	6.50	6	Grade Durham, . . . . .	Hay, corn stover, . . .	None, . . . . .	Corn, . . . . .	3	1
35	2	2	9	7	4.50	3.50	5	Grade Jersey, . . . . .	Hay, . . . . .	Bran, . . . . .	2 qts. meal, 1 qt. bran, .	-	2
36	20	-	98	42	4.90	-	8	Grade and pure Jersey, Durham, Holstein, . . . . .	Pasture (Nov.), hay, corn fodder, .	4 qts. meal and bran, .	Same, . . . . .	-	-
37	13	20	72	82	4	4.10	6	Grade Jersey, . . . . .	Pasture (Nov.), hay, corn fodder, .	4 qts. meal and bran, .	Same, . . . . .	16	3
38	7	8	24	34	3.43	4.25	6	Grade Holstein, Durham, native, .	Pasture (Nov.), rowen, corn fodder, . . . . .	8 qts. cob meal and bran, .	Same, . . . . .	2	6
39	14	14	42	45	3.60	3.21	5	Native, . . . . .	Hay, corn fodder, . . . .	6 qts. meal and bran, .	Same, . . . . .	-	8
40	7	8	23	23	3.28	2.87	7	Grade Holstein, Jersey, Durham, .	Pasture (Nov.), rowen, . .	None, . . . . .	5 qts. cob meal and bran, .	2	6
41	13	13	46	52	3.53	4	7	Grade Jersey, native, . . . .	Pasture (Nov.), hay, corn fodder, .	6 qts. meal and bran, .	Same, . . . . .	1	12
42	0	9	21	32	2.33	3.44	6	Pure and grade Jersey, . . . .	Pasture (Nov.), rowen, corn fodder, . . . . .	4 qts. bran, . . . . .	Same, . . . . .	8	5
43	7	7	18	18	2.57	2.57	5	Grade Jersey, Durham, . . . .	Pasture (Nov.), hay, corn stover, .	None, . . . . .	8 qts. meal and bran, .	-	7

50	9	9	29	35	3.22	3.88	7	Grade Jersey, Holstein, Durham,	Hay, . . . . .	6 qts. bran, . . . . .	Same, . . . . .	2	3	4
51	8	8	26	-	3.25	-	6	Grade Jersey, Durham, Guernsey, Devon, Ayrshire, . . .	Grass (Nov.), hay, . . . . .	3 qts. meal, . . . . .	Same, . . . . .	-	-	-
52	7	7	21	15	3	2.14	6	Grade Jersey, Ayrshire, . . .	Hay, corn fodder, . . . . .	Corn, oats, bran, . . . . .	Same, . . . . .	-	-	-
53	5	6	20	19	4	3.16	4½	Grade Jersey, Guernsey, native, . . .	Hay, corn stover, . . . . .	6 qts. meal and bran, . . . . .	Same, . . . . .	3	3	-
54	4	4	13	8	3.25	2	5½	Grade Jersey, Guernsey, Durham, Ayrshire, . . . . .	Hay, . . . . .	None, . . . . .	None, . . . . .	-	2	2
55	2	3	10	7	5	2.33	4½	Grade Jersey, native, . . . . .	Hay, corn fodder, pumpkins (Nov.), . . . . .	None, . . . . .	Cob meal, . . . . .	-	2	1
56	3	2	11	4	3.67	2	4½	Grade Jersey, Durham, . . . . .	Pasture (Nov.), hay, corn fodder, . . . . .	None, . . . . .	3 qts. meal, . . . . .	-	3	-
57	11	11	35	24	3.18	2.18	6½	Grade Jersey, Ayrshire, . . . . .	Hay, oats, corn fodder, . . . . .	4 qts. meal and bran, . . . . .	Same, . . . . .	-	11	-
58	6	6	10	-	1.67	-	4	Grade Jersey, . . . . .	Pasture (Nov.), hay, corn fodder, . . . . .	None, . . . . .	-	-	-	-
59	14	14	37	22	2.64	1.57	6½	Grade Jersey, Holstein, . . . . .	Hay, oats, corn fodder, . . . . .	None, . . . . .	2 qts. meal, . . . . .	2	6	3
60	3	3	12	20	4	6.67	6	Grade Durham, . . . . .	Pasture (Nov.), hay, . . . . .	8 qts. meal and bran, . . . . .	Same, . . . . .	2	1	-
61	5	4	16	13	3.20	3.25	4½	Grade Jersey, . . . . .	Pasture (Nov.), hay, corn fodder, pumpkins (Nov.), . . . . .	Meal and bran, . . . . .	4 qts. meal and middlings, . . . . .	-	4	-
62	-	6	-	41	-	6.83	5	Grade Jersey, . . . . .	Hay, . . . . .	-	3 qts. meal, . . . . .	4	1	1



*Summary.*

	Creamery A.	Creamery B.
Number of farms contributing, . . . .	131, . . . .	62
Total spaces of cream Nov. (1 day),	3,671, . . . .	1,668
Total spaces of cream Dec. (1 day),	3,470, . . . .	1,593
Total number of cows Nov. (1 day),	1,013, . . . .	483
Total number of cows Dec. (1 day),	1,033, . . . .	456
Lowest space per cow,* . . . .	1 (Farm Nos. 61 and 74),	1.40 (Farm No. 9).
Highest space per cow, . . . .	7.75 (Farm No. 82), .	7.50 (Farm No. 34).
Average spaces per cow, . . . .	3.49, . . . .	3.42
Average age of cows, . . . .	5½ years, . . . .	5½ years.
Average space per cow in station dairy, 5.25.		

\* Excluding cases where milk is sold.

## FEEDING EXPERIMENTS WITH PIGS.

ding annual report contains a summary of a  
ding experiments with pigs, carried on at this  
1884, for the purpose of ascertaining the cost  
required to produce a given quantity of dressed  
first attention in this connection was directed  
profitable disposition of two by-products of the  
y,—skim-milk and buttermilk from creameries.  
y supply of these materials varies, for obvious  
ely on farms, it seemed advisable to devise  
odder rations adapted to different conditions in  
n.

diet in our earlier experiments contained a more  
nt of milk than in our later ones. For several  
e have raised, the whole year around, for every  
farm, a pig for the meat market, to dispose of  
lk. This course necessitated, at times, addi-  
ces of supply of nutritious food. To meet this  
in an economical and profitable way, and by  
are in the reach of every farmer, has been our  
ve have thus far succeeded in our endeavor, may  
ed from a subsequent short review of our pre-  
e of observation. A correct interpretation of  
ding experiment (X.), which forms the principal  
bsequent communication, renders a brief restate-  
results of our earlier experiments advisable.

ur first and second experiments (1884), skim-  
ermilk or both and corn meal furnished the daily  
e first experiment, the relative proportions of  
e of buttermilk and of corn meal remained the  
he beginning to the end of the trial; namely,  
s of corn meal for every quart of skim-milk  
meet the increasing wants of the animals. The  
e consumption per head amounted at the close  
ment to fourteen quarts of skim-milk and forty-  
of corn meal. The nutritive character of the  
ained practically the same during most of the  
ervation. It was, in the case of the buttermilk  
t of digestible nitrogenous food constituents to

from 2.84 to 3.38 parts of non-nitrogenous food constituents; and in case of that of the skim-milk, one of the former to from 2.50 to 2.90 of the latter; the variations being mainly due to the difference in the amount of solid matter in the two kinds of milk.

In the second feeding experiment (1885), the relative proportion between skim-milk or buttermilk and corn meal was different from that in the first one. During the first period of the second experiment, only two ounces of corn meal were added to each quart of milk required to satisfy the animal. As soon, however, as from six to seven quarts per head were consumed daily, four ounces of corn meal were fed for every quart of milk. Another increase in corn meal was made when ten quarts of milk were called for; and again, when twelve quarts were consumed per head. The experiment closed with a daily average ration per head of from ten to twelve quarts of milk, and from eighty to ninety-six ounces of corn meal. In consequence of this course of feeding, the nutritive character of the daily diet was changed from time to time. The periodical increase of corn meal in the daily fodder rations caused the introduction of a larger proportion of non-nitrogenous food constituents, as starch, sugar, fat, etc., in the diet, than of nitrogenous constituents. The experiment began with a diet which contained one part of digestible nitrogenous constituents to 2.7 of non-nitrogenous food constituents, and closed with 1:5 in case of skim-milk and 1:4.5 in case of buttermilk.

The expiration of a contract with a creamery in our vicinity deprived us, at that stage of our investigation, of a liberal supply of buttermilk. A limited supply of home-made skim-milk necessitated a modification of our feeding system, in case that at least six pigs should be engaged in the experiments at one time. It was therefore decided to feed the skim-milk from our herd of six cows, in equal quantities, to six growing pigs, and to supply the additional feed from other suitable sources, including corn meal in part. It seemed also of interest to learn whether the particular course pursued in the previously described experiments of feeding skim-milk from the home dairy with corn meal alone could be improved on; and, if so, in what direction. Gluten

eat bran were chosen, for various reasons, to  
section with corn meal to furnish the additional  
of the diet, as soon as our milk supply became  
This course promised to serve two distinct

ch nitrogenous character of gluten meal and  
offered a chance to secure any desired change  
re character of the feed, as far as the relative  
the digestible nitrogenous and non-nitrogenous  
nts are concerned ; and

duce the net cost of the feed, in case they  
an efficient substitute for larger quantities of  
n account of the larger quantities of certain  
lizing constituents they contain.

ent that an addition of gluten meal or of wheat  
to a diet which previously consisted only of  
l corn meal, tends to increase the commercial  
manurial refuse resulting, is based on the fol-  
lowing considerations :—

Principal fertilizing elements contained in a  
ual parts of gluten meal and wheat bran have  
market value than those contained in an equal  
amount of meal.

admissible, for mere practical purposes, to  
in raising one and the same kind of animals  
of equal weight, a corresponding amount of  
phosphoric acid, of potassium oxide, etc.,  
is fed and stored up in the growing animal.

Therefore, of any or of all of the three essen-  
tial constituents previously specified, in one diet,  
compared with that of another one, counts in favor of  
the former diet as far as net cost of feed is concerned.

It must be acknowledged that, even in one and  
the same feeding experiment, most likely no two animals  
show strictly corresponding relations in that direc-  
tion. It is not less true that it is a most commendable  
feature of general farm management, to consider care-  
fully the relative value of the fertilizing constituents  
of the various fodder articles which present  
themselves for our choice in the compounding of suitable

fodder rations. Our allowance of a loss of thirty per cent. of the essential fertilizing constituents contained in the food consumed, in consequence of the development and growth of the animal, is purposely a liberal one. The adoption of this basis for our estimate tends to strengthen our conclusion that the raising of pigs for the home market can be made a profitable branch of farm industry, even with comparatively limited resources of skim-milk.

The daily supply of skim-milk has not exceeded, at any period, eight quarts of milk during our later experiments, from the third to the ninth inclusive; most of the time it has been from four to five quarts per head. The relative proportion of corn meal, wheat bran and gluten meal has been frequently altered in case of different experiments, as well as at different stages of the same experiment, with varying results. The ninth experiment, which has been described in detail in our sixth annual report, has been, from an economical stand-point, thus far the most successful one. A brief abstract of that experiment may here suffice to show our late mode of compounding fodder rations for pigs at different stages of growth, in connection with the financial results we secured.

The summary includes our entire series of pig feeding described in previous reports, and also the last one, the tenth, which is for the first time published in detail in some succeeding pages.

*Average of Daily Rations (Experiment IX.).*

	Corn Meal (Ounces).	Skim-milk (Quarts).	Wheat Bran (Ounces).	Gluten Meal (Ounces).	Corn and Cob Meal (Ounces).	Feeding Periods.	Nutritive Ratio of Food.
<b>1888.</b>							
April 12 to April 23, .	-	3	-	-	6.	I.	1:2.80
April 24 to May 1, .	-	6	-	-	12.		
May 2 to May 14, .	-	6	3.47	6.94	12.	II.	1:2.53
May 15 to May 28, .	-	6	9.89	19.78	12.		
May 29 to June 4, .	-	6	10.67	21.34	12.	III.	1:3.63
June 5 to June 22, .	-	6	8.65	8.65	34.60		
June 23 to July 3, .	-	6	9.86	9.86	39.44	IV.	1:4.35
July 4 to July 9, .	-	6	7.70	7.70	46.20		
July 10 to July 25, .	56.10	6	9.35	9.35	-		
July 26 to Aug. 8, .	63.00	6	10.50	10.50	-		

Live Weight of Animal.	Nutritive Ratio.
0 to 90 pounds, .	One digestible nitrogenous, 2.66 digestible non-nitrogenous, constituents
0 to 130 pounds, .	One digestible nitrogenous, 3.62 digestible non-nitrogenous, constituents.
0 to 200 pounds, .	One digestible nitrogenous, 4.35 digestible non-nitrogenous, constituents.

tions included in the following summary were the following valuations per ton:—

	Cost.	Manurial Value.
. . . . .	\$24 00	\$7 97
. . . . .	30 00	6 21
er cent. solids), . . .	1.8 cts. gal.	2 25
8 per cent. solids), . .	1.37 " "	1 74
al, . . . . .	\$20 70	6 06
. . . . .	22 50	13 51
. . . . .	22 50	17 49

## Summary of Experiments I. to X.

[Based on the same cost of feed and value of manurial refuse.]

EXPERIMENT.	Number of Pigs.	Average Weight of Pigs at Beginning of Experiment (Pounds)	Average Weight of Pigs at Close of Experiment (Pounds)	Articles of Fodder used.	Nutritive Ratio of Feed.	Pounds of Dry Matter consumed for the Production of One Pound of Dressed Pork.	Total Cost of Feed per Pound of Dressed Pork (Cents).	Manurial Value of Feed per Pound, after deducting Thirty Per Cent. Taken by Pig (Cents).	Net Cost of Feed per Pound of Dressed Pork (Cents).
I. May 21 to Sept. 22, 1884, { a, { b,	3 3	48.8 47.6	239.0 234.9	Skim-milk, corn meal, Buttermilk, corn meal, .	1:2.50 to 1:2.97 1:2.84 to 1:3.38	2.50 to 3.11; average 2.80 2.23 to 2.57; " 2.40.	5.15 4.30	1.70 1.38	3.46 2.92
II. Nov. 5, 1884, to Mar. 21, 1885, { a, { b,	6 6	30.1 28.7	200.7 227.0	Buttermilk, corn meal, . Skim milk, corn meal, .	1:3.5 to 1:4.8 1:2.7 to 1:5.00	3.34 to 4.17; " 2.97 to 3.48; "	5.91 5.51	1.80 1.66	4.11 3.85
III. April 1 to Sept. 16, 1885, . . .	2	49.8	276.3	{ Skim-milk, corn meal, . { Wheat bran, gluten meal, .	1:3.04 to 1:3.76	4.01 to 4.18; "	6.41	2.01	4.40
IV. Dec. 8, 1885, to May 31, 1886, .	2	32.9	152.4	{ Skim-milk, corn meal, . { Wheat bran, gluten meal, .	1:2.64 to 1:4.48	3.77 to 4.08; "	6.33	2.13	4.20
V. Sept. 15, 1886, to Jan. 19, 1887, .	4	32.6	175.0	{ Skim-milk, corn meal, . { Wheat bran, gluten meal, .	1:2.75 to 1:3.57	3.56 to 4.31; "	5.40	2.02	3.38
VI. Feb. 17 to May 2, 1887, . . .	5	54.4	152.8	{ Skim-milk, corn meal, . { Wheat bran, gluten meal, .	1:2.09 to 1:3.23	2.70 to 4.20; "	5.68	1.96	3.74
VII. June 28 to Oct. 26, 1887, . . .	7	24.5	103.3	{ Skim-milk, corn meal, . { Wheat bran, gluten meal, .	1:2.85 to 1:4.30	2.83 to 3.24; "	5.07	1.76	3.39
VIII. Nov. 8, 1887, to March 12, 1888, .	6	25.2	156.4	{ Skim-milk, corn meal, . { Wheat bran, gluten meal, . { Corn and cob meal, .	1:2.30 to 1:4.17	3.02 to 3.46; "	5.32	1.74	3.58
IX. April 12 to Aug. 8, 1888, . . .	6	19.6	164.7	{ Skim milk, corn meal, . { Wheat bran, gluten meal, . { Corn and cob meal, .	1:2.53 to 1:4.35	2.81 to 3.17; "	4.80	1.62	3.27
X. April 26 to Aug. 28, 1889, . . .	7	20.3	186.9	{ Skim-milk, barley meal, . { Wheat bran, gluten meal, .	1:2.90 to 1:4.65	3.40 to 3.81; "	5.60	1.75	4.82

tations in this connection with the management summarized ten feeding experiments, lead to suggestions regarding a proper course of for the meat market:—

as early as practicable, with a well-regulated feeding. During the moderate season, begin animals have reached from eighteen to twenty weight; in the colder seasons, when they twenty-five to thirty pounds.

and for young pigs during their earlier stages of to be somewhat bulky, to promote the exten- digestive organs, and to make them thereafter

A liberal supply of skim-milk or buttermilk, cal increase of corn meal, beginning with two a meal per quart of milk, has given us highly sults.

the character of the diet, at certain stages of a rich nitrogenous diet to that of a wider ratio digestible nitrogenous and non-nitrogenous food of the feed. Begin, for instance, with two n meal to one quart of skim-milk; when the reached from sixty to seventy pounds, use four art; and feed six ounces of meal per quart weight amounts to from one hundred and e hundred and thirty pounds. The superior noticed in case of one and the same diet dur- r stages of growth, will not infrequently be ease seriously during later stages.

ot good economy to raise pigs for the meat exceptionally high weight. To go beyond from and seventy-five to one hundred and eighty y advisable when exceptionally high market used pork can be secured. The quality of the ot to be impaired by an increased deposition of er of assimilating food and of converting it in way into an increase of live weight, decreases ess of age.

well, as far as the cost of feed is concerned, animals against the extremes of the season. riments carried on during moderate seasons itable than those carried on, under otherwise circumstances, during the winter season.



*Weights taken at Time of killing of Pigs fattened at the Experiment Station (in Pounds).*

[Age of pigs when killed, five to eight months.]

NUMBER AND BREED OF FIG.		Live Weight.	Dressed Weight.	Per Cent. of Live Weight lost by Dressing.	Heart.	Lungs.	Liver.	Heart, Lungs and Liver.	Stomach (empty).	Intestinal Fat.
1.	Yorkshire — Berkshire, .	231.25	194.50	15.89	—	—	—	4.25	1.25	4.50
2.	" " .	247.00	203.75	17.50	—	—	—	6.00	1.50	5.00
3.	" " .	218.50	183.25	16.13	—	—	—	4.50	1.25	5.00
4.	Yorkshire — White Chester, .	165.00	132.75	19.50	—	—	—	4.25	1.25	3.75
5.	" " " .	197.75	161.50	18.35	—	—	—	5.00	1.50	4.00
6.	" " " .	198.50	159.50	19.64	—	—	—	5.25	1.25	5.00
7.	Yorkshire — Berkshire, .	253.25	208.50	17.67	—	—	—	5.75	1.25	6.00
8.	" " .	243.25	205.25	15.60	—	—	—	5.25	1.50	4.00
9.	" " .	249.25	209.25	16.00	—	—	—	6.00	1.75	6.00
10.	Yorkshire — White Chester, .	209.00	168.50	19.40	—	—	—	6.00	1.50	4.50
11.	" " " .	191.00	158.50	17.02	—	—	—	5.50	1.25	5.25
12.	" " " .	216.25	173.50	19.77	—	—	—	5.50	1.25	6.00
13.	Mixed, .	196.00	167.50	14.54	—	—	—	4.25	1.25	1.75
14.	" " .	306.00	258.00	15.69	—	—	—	6.50	1.50	5.50
15.	" " .	178.50	150.50	15.69	—	—	—	8.75	1.00	2.50
16.	" " .	216.50	210.00	14.81	—	—	—	5.00	1.25	4.75
17.	" " .	164.00	137.00	16.46	.50	.75	2.25	3.50	—	2.50
18.	" " .	193.25	163.00	15.65	.50	.75	2.75	4.00	—	2.75
19.	" " .	178.25	153.00	14.16	.33	1.25	2.00	3.58	—	1.75
20.	Berkshire — White Chester, .	204.00	162.00	20.59	.63	1.25	3.75	5.63	—	2.38

31.	"	.	.	.	.	184.50	150.00	18.70	.44	1.38	3.32	5.14	-	3.00
32.	"	.	.	.	.	200.75	162.00	19.30	.69	1.56	3.63	5.88	-	3.38
33.	"	.	.	.	.	185.75	152.00	18.17	.56	1.56	2.63	4.75	-	1.88
34.	"	.	.	.	.	190.25	158.00	16.93	.60	1.13	3.00	4.63	-	2.69
35.	"	.	.	.	.	188.75	154.00	18.15	.75	1.19	2.98	4.32	-	2.38
36.	"	.	.	.	.	193.75	168.00	18.45	.75	1.75	2.88	5.98	-	2.25
37.	"	.	.	.	.	203.50	168.50	17.20	.50	1.25	3.19	4.94	-	1.88
38.	White Chester,	.	.	.	.	183.75	154.00	16.19	.25	1.50	2.13	3.88	1.00	2.25
39.	"	.	.	.	.	194.25	162.00	16.61	.25	1.38	2.63	4.26	1.13	3.38
40.	Mixed,	.	.	.	.	207.50	172.50	16.87	.38	1.50	2.25	4.13	0.88	3.75
41.	"	.	.	.	.	211.50	177.00	16.31	.38	1.25	2.50	4.13	0.88	3.63
42.	Grade White Chester,	.	.	.	.	185.00	153.50	17.03	.50	0.94	4.00	5.44	1.19	1.94
43.	"	.	.	.	.	199.00	163.00	18.09	.37	1.31	3.31	4.99	-	1.63
44.	"	.	.	.	.	188.50	151.00	19.89	.41	1.13	3.56	5.13	1.25	1.94
45.	"	.	.	.	.	200.00	162.00	19.00	.63	1.44	4.13	6.20	1.38	1.88
46.	Mixed,	.	.	.	.	192.00	145.50	20.05	.56	1.50	3.69	5.75	1.50	2.81
47.	"	.	.	.	.	177.00	141.00	20.34	.44	0.88	3.13	4.45	1.56	3.00
48.	"	.	.	.	.	197.50	159.00	19.49	.53	1.38	3.50	6.41	1.50	1.50

*Summary.*

	Average Weight (Pounds).	Number Pigs averaged
Live weight, . . . . .	201.23	4
Dressed weight, . . . . .	165.11	4
Per cent. of live weight lost by dressing, . . . . .	17.95	4
Heart, . . . . .	.50	3
Lungs, . . . . .	1.26	3
Liver, . . . . .	3.15	3
Heart, lungs and liver, . . . . .	4.99	4
Stomach (empty), . . . . .	1.80	2
Intestinal fat, . . . . .	3.26	4

The intestinal fat, as may be seen from the preceding statement, varies from 1.75 to 6.00 pounds; its deposition, as a rule, has rapidly increased after the animals pass about 180 to 200 pounds of live weight.

*Tenth Feeding Experiment (1889).*

[Skim-milk, barley meal, wheat bran and gluten meal.]

The general course pursued in the management of this experiment is essentially the same as that adopted in the preceding ones (VII., VIII. and IX.). The main alteration consists in the circumstance that barley meal has been substituted for corn meal in the daily diet of the animals on trial.

Seven pigs, grades of White Chester and Berkshires, weighing from 14 to 23 pounds each at the beginning, were reserved for our observation. The experiment began August 23, and closed August 28, lasting thus 127 days. The weight gained during that period varied in case of different animals from 162 to 178½ pounds. The average live weight gained of the whole lot was 169½ pounds per head, or 1½ pounds per day. The amount of skim-milk consumed daily per head remained practically the same, after the first week five quarts. To every quart of milk required were added two ounces of barley meal. The additional feed subsequently needed consisted of a mixture of two weight parts of gluten meal and one of wheat bran. At the close of the second month of our trial, when the live weights of the various animals amounted to from 120 to 130 pounds each, the

a mixture of four weight parts of barley meal  
 at part each of gluten meal and wheat bran was  
 original quantity of skim-milk,—five quarts  
 d. The subsequent tabular statement shows  
 the changes in the quantities of the daily fodder  
 so their nutritive character at different stages of  
 entire experiment might be divided practically  
 ing periods :—

	Live Weight.	Nutritive Ratio.
. . . . .	20 to 90 pounds.	1:2.95
. . . . .	90 to 130 pounds.	1:4.20
. . . . .	130 to 200 pounds.	1:4.61

*Stage of Daily Rations (Experiment X.).*

	Barley Meal (Ounces).	Skim-milk (Quarts).	Wheat Bran (Ounces).	Gluten Meal (Ounces).	Feeding Periods.	Nutritive Ratio.
1, . . . .	6.	3.	—	—	I.	1:2.90
13, . . . .	10.	5.	—	—		
23, . . . .	11.	5.5	4.00	8.00		
4, . . . .	10.	5.	7.00	14.00	II.	1:2.99
17, . . . .	10.	5.	11.90	23.80		
8, . . . .	37.80	5.	9.47	9.47		
22, . . . .	47.60	5.	11.90	11.90	III.	1:4.12
12, . . . .	58.80	5.	9.80	9.80		
27, . . . .	64.20	5.	10.70	10.70	IV.	1:4.61

of dry vegetable matter of the feed consumed  
 dressed pork produced varies in case of dif-  
 from 3.40 to 3.81 pounds, the mean being 3.6  
 result is less favorable than those obtained in  
 eriment, where the amount of dry vegetable  
 ned per pound of dressed pork obtained was  
 y from 2.61 to 3.17 pounds, with an average  
 8 pounds. As both experiments were con-

ducted during the same period of the year,—summer season,—the results apparently point towards a higher nutritive effect of the corn meal, as compared with that of barley meal, under conditions like ours. The final decision in this direction will be left to further trials.

The higher market price of the barley meal, as compared with that of corn meal, at present market rates, is an additional cause of a less favorable financial result than in most of our late experiments, from VI. to IX. inclusive. The average net cost per pound of dressed pork, in our tenth experiment, amounted to 4.29 cents. We received  $5\frac{3}{4}$  cents per pound. For more details, see farther on.

*Market Cost of Fodder Articles used.*

Barley meal,	\$30.00 per ton.	Wheat bran,	\$18.50 per ton.
Skim-milk,	1.8 cts. per gal.	Gluten meal,	\$22.00 per ton.

*Valuation of Essential Fertilizing Constituents in the Various Articles of Fodder used.*

Nitrogen, 17 cents per pound; phosphoric acid, 6 cents; potassium oxide,  $4\frac{1}{2}$  cents.

[Per cent.]

	Barley Meal.	Skim-milk.	Wheat Bran.	Gluten Meal.
Moisture, . . . . .	12.90	89.78	10.92	10.19
Nitrogen, . . . . .	1.507	.52	2.447	4.230
Phosphoric acid, . . . . .	.664	.19	2.900	.392
Potassium oxide, . . . . .	.342	.20	1.637	.049
Valuation per 2,000 pounds, . . .	\$6 23	\$2 17	\$13 27	\$14 90

(1)

PERIODS.	Total Amount of Barley Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day during Period.
<b>1889.</b>								lb. oz.
April 23 to May 13, .	11.63	93.00	-	-	1: 2.90	23.00	41.50	14
May 14 to June 17, .	23.62	189.00	18.69	37.38	1: 2.99	41.50	88.50	1 5
June 18 to July 22, .	95.64	175.00	23.91	23.91	1: 4.17	88.50	135.00	1 5
July 23 to Aug. 28, .	132.08	184.00	22.18	22.18	1: 4.56	135.00	185.00	1 6

*of Feed consumed from April 23 to August 28.*

ley meal, equal to dry matter, . . .	229.92 pounds.
-milk, equal to dry matter, . . .	142.16 pounds.
at bran, equal to dry matter, . . .	57.71 pounds.
ten meal, equal to dry matter, . . .	74.96 pounds.

of dry matter, . . . . . 504.75 pounds.

mal at beginning of experiment, . . .	23.00 pounds.
mal at time of killing, . . .	185.00 pounds.
d during experiment, . . .	162.00 pounds.
time of killing, . . .	153.50 pounds.
dressing, . . .	31.50 pounds, or 17.03 per cent.
ained during experiment, . . .	134.41 pounds.

*of Feed consumed during Experiment.*

ley meal, at \$30.00 per ton, . . .	\$3 96
n-milk, at 1.8 cents per gallon, . . .	2 88
at bran, at \$18.50 per ton, . . .	60
ten meal, at \$22.00 per ton, . . .	92

\$8 36

matter fed yielded 1 pound of live weight, and  
dry matter yielded 1 pound of dressed weight.  
production of 1 pound of dressed pork, 6.22

(2)

	Total Amount of Bar- ley Meal consumed (Pounds).	Total Amount of Skim- milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Glu- ten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day during Period.
	11.63	93.00	-	-	1 : 2.90	25.25	45.00	lb. oz.
	23.62	189.00	18.75	37.50	1 : 2.99	45.00	94.00	1 6
	87.36	175.00	21.84	21.84	1 : 4.09	94.00	142.50	1 6
	187.88	184.00	22.98	22.98	1 : 4.60	142.50	199.50	1 8

*of Feed consumed from April 23 to August 28.*

ley meal, equal to dry matter, . . .	226.89 pounds.
n-milk, equal to dry matter, . . .	142.16 pounds.
at bran, equal to dry matter, . . .	56.63 pounds.
ten meal, equal to dry matter, . . .	73.93 pounds.

of dry matter, . . . . . 499.61 pounds.

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Live weight of animal at beginning of experiment,	25.25 p
Live weight of animal at time of killing,	199.00 p
Live weight gained during experiment,	173.75 p
Dressed weight at time of killing,	163.00 p
Loss in weight by dressing,	36.00 pounds, or 18.09 p
Dressed weight gained during experiment,	142.32 p

## *Cost of Feed consumed during Experiment.*

260.49 pounds barley meal, at \$30.00 per ton,	.	.	.
160.25 gallons skim-milk, at 1.8 cents per gallon,	.	.	.
63.57 pounds wheat bran, at \$18.50 per ton,	.	.	.
82.32 pounds gluten meal, at \$22.00 per ton,	.	.	.

2.88 pounds of dry matter fed yielded 1 pound of live weight, and  
 3.51 pounds of dry matter yielded 1 pound of dressed weight.  
 Cost of feed for production of 1 pound of dressed pork, 5.82 cents.

(3)

PERIODS.	Total Amount of Bar- ley Meal consumed (Pounds).	Total Amount of Skim- milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Glu- ten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).
<b>1889.</b>							
April 23 to May 13,	11.63	93.00	-	-	1:2.90	19.75	38.5
May 14 to June 17,	23.40	187.00	15.87	31.76	1:2.90	38.50	84.0
June 18 to July 22,	84.88	175.00	21.22	21.22	1:4.06	84.00	127.8
July 23 to Aug. 28,	130.60	184.00	23.27	23.27	1:4.61	127.50	188.3

## *Total Amount of Feed consumed from April 23 to August*

259.51 pounds barley meal, equal to dry matter,	226.03
639.00 quarts skim-milk, equal to dry matter,	141.71
60.36 pounds wheat bran, equal to dry matter,	53.77
76.25 pounds gluten meal, equal to dry matter,	68.48
Total amount of dry matter,	489.99

Live weight of animal at beginning of experiment,	19.75
Live weight of animal at time of killing,	188.50
Live weight gained during experiment,	168.75
Dressed weight at time of killing,	151.00
Loss in weight by dressing,	37.50 pounds, or 19.89 p
Dressed weight gained during experiment,	135.19

*f Feed consumed during Experiment.*

ey meal, at \$30.00 per ton, . . . .	\$3 89
-milk, at 1.8 cents per gallon, . . . .	2 88
at bran, at \$18.50 per ton, . . . .	56
en meal, at \$22.00 per ton, . . . .	84
	<hr/>
	\$8 17

matter fed yielded 1 pound of live weight,  
of dry matter yielded 1 pound of dressed

roduction of 1 pound of dressed pork, 6.04

(4)

Total Amount of Bar- ley Meal consumed (Pounds).	Total Amount of Skim- milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Oat- meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day during Period.
11.63	93.00	-	-	1: 2.90	23.00	42.00	lb. oz. 14
23.62	189.00	18.06	36.12	1: 2.99	42.00	92.00	1 7
89.64	175.00	22.41	22.41	1: 4.11	92.00	139 50	1 6
141.42	184.00	23.57	23.57	1: 4.62	139.50	200.00	1 10

*f Feed consumed from April 23 to August 28.*

ey meal, equal to dry matter, . . .	231.96 pounds.
milk, equal to dry matter, . . .	142.16 pounds.
at bran, equal to dry matter, . . .	57.05 pounds.
en meal, equal to dry matter, . . .	73.73 pounds.

of dry matter, . . . . . 504.90 pounds.

mal at beginning of experiment, . . . 23.00 pounds.

mal at time of killing, . . . . . 200.00 pounds.

d during experiment, . . . . . 177.00 pounds.

ime of killing, . . . . . 162.00 pounds.

dressing, . . . . . 38.00 pounds, or 19.00 per cent.

ned during experiment, . . . . . 143.37 pounds.

*f Feed consumed during Experiment.*

ey meal, at \$30.00 per ton, . . . .	\$3 99
-milk, at 1 8 cents per gallon, . . . .	2 88
at bran, at \$18 50 per ton, . . . .	59
en meal, at \$22.00 per ton, . . . .	91
	<hr/>
	\$8 37



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2.85 pounds of dry matter fed yielded 1 pound of live weight,  
and 3.52 pounds of dry matter yielded 1 pound of dressed  
weight.

Cost of feed for production of 1 pound of dressed pork, 5.84  
cents.

(5)

PERIODS.	Total Amount of Bar- ley Meal consumed (Pounds).	Total Amount of Skim- milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Glu- ten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period. (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day during Period.
<b>1889.</b>								lb. oz.
April 30 to May 13, .	5.75	46.00	-	-	1: 2.90	18.50	30.50	14
May 14 to June 17, .	21.88	175.00	17.38	34.75	1: 2.99	30.50	83.00	1 8
June 18 to July 22, .	96.36	175.00	24.09	24.09	1: 4.17	83.00	135.75	1 8
July 23 to Aug. 28, .	146.52	184.00	24.42	24.42	1: 4.65	135.75	182.00	1 4

## *Total Amount of Feed consumed from April 30 to August 28.*

270.51 pounds barley meal, equal to dry matter, . . . 235.61 pounds  
580.00 quarts skim-milk, equal to dry matter, . . . 128.63 pounds  
65.89 pounds wheat bran, equal to dry matter, . . . 58.69 pounds  
83.26 pounds gluten meal, equal to dry matter, . . . 74.78 pounds

Total amount of dry matter, . . . . . 497.71 pounds

Live weight of animal at beginning of experiment, . . . 18.50 pounds  
Live weight of animal at time of killing, . . . 182.00 pounds  
Live weight gained during experiment, . . . 163.50 pounds  
Dressed weight at time of killing, . . . 145.50 pounds  
Loss in weight by dressing, . . . 36.50 pounds, or 20.05 per cent  
Dressed weight gained during experiment, . . . 130.72 pounds

## *Cost of Feed consumed during Experiment.*

270.51 pounds barley meal, at \$30.00 per ton, . . . \$4 0  
145.00 gallons skim-milk, at 1.8 cents per gallon, . . . 2 6  
65.89 pounds wheat bran, at \$18.50 per ton, . . . 6  
83.26 pounds gluten meal, at \$22.00 per ton, . . . 9

\$8 2

3.04 pounds of dry matter fed yielded 1 pound of live weight,  
and 3.81 pounds of dry matter yielded 1 pound of dressed  
weight.

Cost of feed for production of 1 pound of dressed pork, 6.27  
cents.

(6)

	Total Amount of Bar- ley Meal consumed (Pounds).	Total Amount of Skim- milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Glu- ten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day during Period.
	5.75	46.00	-	-	1:2.90	14.00	25.75	lb. oz.
.	21.88	175.00	13.13	26.25	1:2.98	25.75	71.50	1 5
.	89.55	175.00	22.37	22.37	1:4.11	71.50	121.00	1 7
.	140.46	184.00	23.41	23.41	1:4.61	121.00	177.00	1 8

*of Feed consumed from April 30 to August 28.*

Barley meal, equal to dry matter, . . .	224.36 pounds.
Skim-milk, equal to dry matter, . . .	128.63 pounds.
Wheat bran, equal to dry matter, . . .	52.48 pounds.
Gluten meal, equal to dry matter, . . .	64.69 pounds.
<b>Total of dry matter, . . . . .</b>	<b>470.16 pounds.</b>

Animal at beginning of experiment, . . .	14.00 pounds.
Animal at time of killing, . . . . .	177.00 pounds.
Feed during experiment, . . . . .	163.00 pounds.
Animal at time of killing, . . . . .	141.00 pounds.
Loss during dressing, . . . . .	36.00 pounds, or 20.34 per cent.
Gain during experiment, . . . . .	129.85 pounds.

*of Feed consumed during Experiment.*

Barley meal, at \$30.00 per ton, . . . . .	\$3 86
Skim-milk, at 1.8 cents per gallon, . . . . .	2 61
Wheat bran, at \$18.50 per ton, . . . . .	54
Gluten meal, at \$22.00 per ton, . . . . .	79
<b>Total, . . . . .</b>	<b>\$7 80</b>

Barley matter fed yielded 1 pound of live weight,  
 1.5 of dry matter yielded 1 pound of dressed

production of 1 pound of dressed pork, 6.01

(7)

PERIODS.	Total Amount of Bar- ley Meal consumed (Pounds).	Total amount of Skim- milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Glu- ten meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day during Period.
<b>1889.</b>								lb. oz.
April 30 to May 13, .	5.75	46.00	-	-	1:2.90	18.75	30.25	13
May 14 to June 17, .	21.88	175.00	16.44	32.88	1:2.99	30.25	79.75	1 7
June 18 to July 22, .	96.12	175.00	24.03	24.03	1:4.17	79.75	134.50	1 9
July 23 to Aug. 28, .	141.84	184.00	23.64	23.64	1:4.62	134.50	197.50	1 11

*Total Amount of Feed consumed from April 30 to August 28.*

265.59 pounds barley meal, equal to dry matter, . . .	231.33 pounds.
580.00 quarts skim-milk, equal to dry matter, . . .	128.63 pounds.
64.11 pounds wheat bran, equal to dry matter, . . .	57.11 pounds.
80.55 pounds gluten meal, equal to dry matter, . . .	72.34 pounds.

Total amount of dry matter, . . . . . 489.41 pounds.

Live weight of animal at beginning of experiment, . . . . .	18.75 pounds.
Live weight of animal at time of killing, . . . . .	197.50 pounds.
Live weight gained during experiment, . . . . .	178.75 pounds.
Dressed weight at time of killing, . . . . .	159.00 pounds.
Loss in weight by dressing, . . . . .	38.50 pounds, or 19.49 per cent.
Dressed weight gained during experiment, . . . . .	143.91 pounds.

*Cost of Feed consumed during Experiment.*

265.59 pounds barley meal, at \$30.00 per ton, . . . . .	\$3 98
145.00 gallons skim-milk, at 1.8 cents per gallon, . . . . .	2 61
64.11 pounds wheat bran, at \$18.50 per ton, . . . . .	59
80.55 pounds gluten meal, at \$22.00 per ton, . . . . .	89
	<hr/>
	\$8 07

2.74 pounds of dry matter fed yielded 1 pound of live weight,  
and 3.40 pounds of dry matter yielded 1 pound of dressed  
weight.

Cost of feed for production of 1 pound of dressed pork, 5.61  
cents.

*Summary of Experiment (X).*

Barley meal (Pounds).	Skim-milk (Gallons).	Wheat Bran (Pounds).	Gluten Meal (Pounds).	Live Weight gained during Experiment (Pounds).	Dressed Weight gained during Experiment (Pounds).	Cost per Pound of Dressed Pork (Cents).
263.97	160.25	64.78	83.47	162.00	134.41	6.22
260.49	160.25	63.57	82.32	173.75	142.32	5.82
259.51	159.75	60.36	76.25	168.75	135.19	6.04
266.31	160.25	64.04	82.10	177.00	143.37	5.84
270.51	145.00	65.89	83.26	163.50	130.72	6.27
257.69	145.00	58.91	72.03	163.00	129.85	6.01
265.59	145.00	64.11	80.55	178.75	143.91	5.61
243.97	1,075.50	441.66	559.98	1,186.75	959.77	-

*Feed consumed during the Above-stated Experiment.*

Barley meal, at \$30.00 per ton, . . .	\$27 66
Skim-milk, at 1.8 cents per gallon, . . .	19 36
Wheat bran, at \$18.50 per ton, . . .	4 08
Gluten meal, at \$22.00 per ton, . . .	6 16
	<hr/> \$57 26

Feed for production of 1 pound of dressed  
pork, . . .

*Cost of Feed consumed during the Above-stated Experiment.*

Skim-milk.	Wheat Bran.	Gluten Meal.	Total.
\$10 13	\$2 93	\$4 17	\$22 97

Cost of feed for production of 1 pound of dressed pork,  
as above, . . .  
Total for the production of 1 pound of dressed pork, 4.29

*Barley Meal (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	12.90	258.00	-	-	} 1:8.81
Dry matter, . . . . .	87.00	1,742.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	2.30	46.00	-	-	
“ cellulose, . . . . .	7.11	142.20	17.06	12	
“ fat, . . . . .	1.94	38.80	26.38	68	
“ protein (nitrogenous matter), . . . . .	10.80	216.00	168.48	78	
Non-nitrogenous extract matter, . . . . .	77.85	1,557.00	1,401.30	90	
	100.00	2,000.00	1,613.22	-	

*Skim-milk (Average).*

[One quart equals 2.17 pounds.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	89.78	1,795.60	-	-	} 1:2.13
Dry matter, . . . . .	10.22	204.40	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.85	137.00	-	-	
“ cellulose, . . . . .	-	-	-	-	
“ fat, . . . . .	3.82	76.40	76.40	100	
“ protein (nitrogenous matter), . . . . .	31.60	632.00	632.00	100	
Non-nitrogenous extract matter, . . . . .	57.73	1,155.60	1,155.60	100	
	100.00	2,000.00	1,864.00	-	

*Wheat Bran (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
° C., . . .	10.92	218.40	—	—	} 1:3.99
. . . . .	89.08	1,781.60	—	—	
	100.00	2,000.00	—	—	
<i>Dry Matter.</i>					
. . . . .	7.00	140.00	—	—	
e., . . . .	11.52	230.40	46.08	20	
. . . . .	5.43	108.60	86.88	80	
(nitrogenous r), . . . .	17.17	343.40	302.19	88	
us extract . . . . .	58.88	1,177.60	942.08	80	
	100.00	2,000.00	1,377.23	—	

*Gluten Meal (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
° C., . . .	10.19	203.80	—	—	} 1:2.86
. . . . .	89.81	1,796.20	—	—	
	100.00	2,000.00	—	—	
<i>Dry Matter.</i>					
. . . . .	.57	11.40	—	—	
e., . . . .	.56	11.20	3.81	34	
. . . . .	6.40	128.00	97.28	76	
(nitrogenous r), . . . .	29.45	589.00	500.65	85	
us extract . . . . .	63.02	1,260.40	1,184.78	94	
	100.00	2,000.00	1,786.52	—	

## VI. FODDER ANALYSES. (1889.)

The majority of the analyses stated under the above heading are made of fodder articles which have been used either during the past year in connection with some of our feeding experiments, or have been raised upon the grounds of the station. Some articles sent on by outside parties are added, on account of the special interest they may present to others.

In presenting these analyses, it seems but proper to call the attention of farmers once more forcibly to a careful consideration of the following facts.

The composition of the various articles of food used in farm practice exerts a decided influence on the manurial value of the animal excretions, resulting from their use in the diet of different kinds of farm live stock. The more potash, phosphoric acid, and, in particular, nitrogen, a fodder contains, the more valuable will be, under otherwise corresponding circumstances, the manurial residue left behind after it has served its purpose as a constituent of the food consumed.

As the financial success in a mixed farm management depends, in a considerable degree, on the amount, the character and the cost of the manurial refuse material secured in connection with the special farm industry carried on, it needs no further argument to prove that the relations which exist between the composition of the fodder and the value of the manure resulting deserve the careful consideration of the farmer, when devising an efficient and at the same time an economical diet for his live stock.

The higher or lower commercial value of the manurial refuse left behind after the feed has accomplished its purpose in a satisfactory degree, decides its actual or net cost in farm industry. A disregard of this circumstance renders, in many instances, a remunerative dairying not less doubtful than a profitable feeding of live stock for the meat market.

•

*Corn Meal.*

[Amherst Mill.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
100° C., . . .	16.44	328.80	-	-	1:7.92
. . . . .	83.56	1,671.20	-	-	
	100.00	2,000.00	-	-	
<i>of Dry Matter.</i>					
. . . . .	2.02	40.40	-	-	
ose, . . . . .	2.09	41.80	14.21	34	
. . . . .	3.47	69.40	52.74	76	
n (nitrogenous ter), . . . . .	12.27	245.40	208.69	85	
ous extract . . . . .	80.15	1,603.00	1,506.82	94	
	100.00	2,000.00	1,782.46	-	

*Corn Meal.*

[Amherst Mill.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
100° C., . . .	12.13	242.60	-	-	1:9.68
. . . . .	87.87	1,757.40	-	-	
	100.00	2,000.00	-	-	
<i>of Dry Matter.</i>					
. . . . .	1.46	29.20	-	-	
ose, . . . . .	1.79	35.80	12.17	34	
. . . . .	4.36	87.20	66.27	76	
n (nitrogenous ter), . . . . .	10.44	208.80	177.48	85	
ous extract . . . . .	81.95	1,639.00	1,540.66	94	
	100.00	2,000.00	1,796.58	-	



*Corn Meal.*

[Amherst Mill.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	10.71	214.20	-	-	1:10
Dry matter, . . . . .	89.29	1,785.80	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.00	20.00	-	-	
“ cellulose, . . . . .	1.74	34.80	11.83	34	
“ fat, . . . . .	4.22	84.40	64.14	76	
“ protein (nitrogenous matter), . . . . .	10.19	203.80	173.23	85	
Non-nitrogenous extract matter, . . . . .	82.85	1,657.00	1,557.60	94	
	100.00	2,000.00	1,806.80	-	

*Corn Meal.*

[Amherst Mill.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	11.98	239.60	-	-	1:8.47
Dry matter, . . . . .	88.02	1,760.40	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.56	31.20	-	-	
“ cellulose, . . . . .	1.85	37.00	12.58	34	
“ fat, . . . . .	4.69	93.80	71.29	76	
“ protein (nitrogenous matter), . . . . .	11.79	235.80	200.43	85	
Non-nitrogenous extract matter, . . . . .	80.11	1,602.20	1,506.07	94	
	100.00	2,000.00	1,790.37	-	

*Corn Meal.*

[Amberst Mill.]

4 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
P. C., . . .	13.36	—	—	—	1:9.17
. . .	86.64	—	—	—	
	100.00	—	—	—	
Dry Matter.	1.28	25.60	—	—	
. . .	2.28	45.60	15.50	34	
. . .	3.18	63.60	48.34	76	
Nitrogenous	10.82	216.40	183.94	85	
extract	82.44	1,648.80	1,549.87	94	
	100.00	2,000.00	1,797.65	—	

*Corn Meal.*

[Amberst Mill.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
P. C., . . .	15.51	310.20	—	—	1:8.54
. . .	84.49	1,689.80	—	—	
	100.00	2,000.00	—	—	
Dry Matter.	1.60	32.00	—	—	
. . .	1.74	34.80	11.83	34	
. . .	4.54	90.80	69.01	76	
Nitrogenous	11.69	233.80	198.73	85	
extract	80.43	1,608.60	1,512.08	94	
	100.00	2,000.00	1,791.65	—	

## 128 AGRICULTURAL EXPERIMENT STATION. [Jan.

*Corn Meal.*

[Amherst Mill.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	11.32	226.40	-	-	1 : 9.89
Dry matter, . . . . .	88.68	1,773.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.53	30.60	-	-	
“ cellulose, . . . . .	1.20	24.00	8.16	34	
“ fat, . . . . .	4.30	86.00	65.36	76	
“ protein (nitrogenous matter), . . . . .	10.26	205.20	174.42	85	
Non-nitrogenous extract matter, . . . . .	82.71	1,654.20	1,554.95	94	
	100.00	2,000.00	1,802.89	-	

*Corn Meal.*

[Amherst Mill.]

88.50 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	10.05	201.00	-	-	1 : 9.14
Dry matter, . . . . .	89.95	1,799.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.63	32.60	-	-	
“ cellulose, . . . . .	1.34	26.80	9.11	34	
“ fat, . . . . .	4.18	83.60	63.54	76	
“ protein (nitrogenous matter), . . . . .	10.98	219.80	186.66	85	
Non-nitrogenous extract matter, . . . . .	81.87	1,637.40	1,539.15	94	
	100.00	2,000.00	1,798.46	-	

*Wheat Bran.*

[Amherst Mill.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
° C., . . .	9.57	191.40	—	—	1 : 4.06
. . . . .	90.43	1,808.60	—	—	
	100.00	2,000.00	—	—	
<i>Dry Matter.</i>					
. . . . .	5.90	118.00	—	—	
. . . . .	10.08	201.60	40.32	20	
. . . . .	4.78	95.60	76.48	80	
nitrogenous					
(r), . . . . .	17.06	341.20	302.26	88	
s extract					
. . . . .	62.18	1,243.60	994.88	80	
	100.00	2,000.00	1,413.94	—	

*Wheat Bran.*

[Amherst Mill.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
° C., . . .	11.34	226.80	—	—	1 : 3.70
. . . . .	88.66	1,773.20	—	—	
	100.00	2,000.00	—	—	
<i>Dry Matter.</i>					
. . . . .	6.56	131.20	—	—	
. . . . .	11.27	225.40	45.08	20	
. . . . .	4.64	92.80	74.24	80	
nitrogenous					
(r), . . . . .	18.13	362.60	319.09	88	
s extract					
. . . . .	59.40	1,188.80	950.40	80	
	100.00	2,000.00	1,388.81	—	

*Wheat Bran.*

[Amherst Mill.]

40.11 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digest- ible in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	9.34	186.80	—	—	1 : 3.63
Dry matter, . . . . .	90.66	1,813.20	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.67	133.40	—	—	
“ cellulose, . . . . .	10.88	217.60	43.52	20	
“ fat, . . . . .	3.59	71.80	57.44	80	
“ protein (nitrogenous matter), . . . . .	18.13	362.60	319.09	88	
Non-nitrogenous extract matter, . . . . .	60.73	1,214.60	971.68	80	
	100.00	2,000.00	1,391.73	—	

*Wheat Bran.*

[Amherst Mill.]

19.56 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digest- ible in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	10.41	208.20	—	—	1 : 4.08
Dry matter, . . . . .	89.59	1,791.80	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.99	139.80	—	—	
“ cellulose, . . . . .	12.02	240.40	48.08	20	
“ fat, . . . . .	5.46	119.20	95.36	80	
“ protein (nitrogenous matter), . . . . .	17.02	340.40	299.55	88	
Non-nitrogenous extract matter, . . . . .	58.51	1,170.20	936.16	80	
	100.00	2,000.00	1,379.15	—	

*Wheat Bran.*

[Amherst Mill.]

per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
C., . . .	11.42	228.40	-	-	1 : 3.97
. . . . .	88.58	1,771.60	-	-	
	100.00	2,000.00	-	-	
ry Matter.	7.00	140.00	-	-	
. . . . .	11.03	220.60	44.12	20	
. . . . .	5.40	108.00	86.40	80	
nitrogenous	17.31	346.20	304.66	88	
extract	59.26	1,185.20	948.16	80	
. . . . .	100.00	2,000.00	1,383.34	-	

*Wheat Bran.*

[Amherst Mill.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
C., . . .	8.85	177.00	-	-	1 : 4.23
. . . . .	91.15	1,823.00	-	-	
	100.00	2,000.00	-	-	
ry Matter.	7.54	150.80	-	-	
. . . . .	9.64	192.80	38.56	20	
. . . . .	5.16	103.20	82.52	80	
nitrogenous	16.45	329.00	289.52	88	
extract	61.21	1,224.20	979.36	80	
. . . . .	100.00	2,000.00	1,389.96	-	

# 132 AGRICULTURAL EXPERIMENT STATION. [Jan.

## Wheat Bran.

[I. sent on by T. P. Root, Barre, Mass.; II. and III. sent on by E. D. Gibson, Ashburnham, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	8.10	11.36	11.64
Dry matter, . . . . .	91.90	88.64	88.36
	100.00	100.00	100.00
<i>Analysis of Dry Matter.</i>			
Crude ash, . . . . .	6.89	6.98	7.42
“ cellulose, . . . . .	10.73	5.95	5.60
“ fat, . . . . .	5.40	7.49	9.43
“ protein (nitrogenous matter), . . . . .	16.73	17.97	16.13
Non-nitrogenous extract matter, . . . . .	60.25	61.61	61.42
	100.00	100.00	100.00
Passed screen 144 meshes to square inch, . . . . .	29.57	24.89	16.03

## Gluten Meal.

[Springfield, Mass.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . . .	9.49	189.80	—	—	1:2.84
Dry matter, . . . . .	90.51	1,810.20	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	.04	.80	—	—	
“ cellulose, . . . . .	.27	5.40	1.84	34	
“ fat, . . . . .	6.69	133.80	101.69	76	
“ protein (nitrogenous matter), . . . . .	29.87	597.40	507.79	85	
Non-nitrogenous extract matter, . . . . .	63.13	1,262.60	1,186.84	94	
	100.00	2,000.00	1,798.16	—	

*Gluten Meal.*

[Springfield, Mass.]

per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
C., . . .	10.50	210.00	-	-	1 : 2.93
. . . . .	89.50	1,790.00	-	-	
	100.00	2,000.00	-	-	
ry Matter.					
. . . . .	.34	6.80	-	-	
. . . . .	.41	8.20	2.79	34	
. . . . .	7.08	141.60	107.62	76	
nitrogenous					
, . . . .	29.19	583.80	496.23	85	
extract					
. . . . .	62.98	1,259.60	1,184.02	94	
	100.00	2,000.00	1,790.66	-	

*Gluten Meal.*

[Springfield, Mass.]

per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
C., . . .	11.29	225.80	-	-	1 : 2.59
. . . . .	88.71	1,774.20	-	-	
	100.00	2,000.00	-	-	
ry Matter.					
. . . . .	.73	14.60	-	-	
. . . . .	.69	13.80	4.69	34	
. . . . .	4.08	81.60	62.02	76	
nitrogenous					
, . . . .	30.86	617.20	524.62	85	
extract					
. . . . .	63.64	1,272.80	1,196.43	94	
	100.00	2,000.00	1,787.76	-	



## 134 AGRICULTURAL EXPERIMENT STATION. [Jan.

*Gluten Meal.*

[Springfield, Mass.]

51.93 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	9.89	197.80	-	-	1:2.79
Dry matter, . . . . .	90.11	1,802.20	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	.79	15.80	-	-	
“ cellulose, . . . . .	.71	14.20	4.83	34	1:2.79
“ fat, . . . . .	5.72	114.40	86.94	76	
“ protein (nitrogenous matter), . . . . .	29.73	594.40	505.24	85	
Non-nitrogenous extract matter, . . . . .	63.06	1,261.20	1,185.53	94	
	100.00	2,000.00	1,782.54	-	

*Gluten Meal.*

[Sent on from Boston, Mass.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	7.85	157.00	-	-	1:1.99
Dry matter, . . . . .	92.15	1,843.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.82	36.40	-	-	
“ cellulose, . . . . .	1.61	32.20	10.95	34	1:1.99
“ fat, . . . . .	17.36	347.20	263.87	76	
“ protein (nitrogenous matter), . . . . .	41.10	822.00	698.70	85	
Non-nitrogenous extract matter, . . . . .	38.11	762.20	716.47	94	
	100.00	2,000.00	1,689.99	-	

*Gluten Meal.*

Sent on by W. H. Fairbanks, Sudbury, Mass.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
C., . . .	9.62	192.40	-	-	1 : 9.63
. . . .	90.38	1,807.60	-	-	
	100.00	2,000.00	-	-	
ry Matter.	.95	19.00	-	-	
. . . .	4.26	85.20	28.97	34	
. . . .	7.82	156.40	118.86	76	
nitrogenous	24.34	486.80	413.78	85	
extract	62.63	1,252.60	1,177.44	94	
. . . .	100.00	2,000.00	1,739.05	-	

*Gluten Meal.*

[Springfield, Mass.]

per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per cent. of Di- gestibility of Constituents.	Nutritive Ratio.
C., . . .	9.80	196.00	-	-	1 : 2.58
. . . .	90.92	1,804.00	-	-	
	100.00	2,000.00	-	-	
ry Matter.	1.25	25.00	-	-	
. . . .	1.75	35.00	11.90	34	
. . . .	7.00	140.00	106.40	76	
nitrogenous	31.25	625.00	551.25	85	
extract	58.75	1,175.00	1,104.50	94	
. . . .	100.00	2,000.00	1,774.05	-	

*Old Process Linseed Meal.*

[Springfield, Mass.]

75.52 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per cent. of Di- gestibility of Constituents.	Nutritive Ratio.	
Moisture at 100° C, . . .	10.46	209.20	-	-	} 1: 1.63	
Dry matter, . . . .	89.54	1,790.80	-	-		
	100.00	2,000.00	-	-		
<i>Analysis of Dry Matter.</i>						
Crude ash, . . . .	7.08	141.60	-	-		
" cellulose, . . . .	8.51	170.20	44.25	26		
" fat, . . . .	7.98	159.60	145.24	91		
" protein (nitrogenous matter), . . . .	38.67	773.40	671.86	87		
Non-nitrogenous extract matter, . . . .	37.76	755.20	687.23	91		
	100.00	2,000.00	1,548.58	-		

*Old Process Linseed Meal (Fine).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.	
Moisture at 100° C; . . .	7.48	149.60	-	-	} 1:1.76	
Dry matter, . . . .	92.52	1,850.40	-	-		
	100.00	2,000.00	-	-		
<i>Analysis of Dry Matter.</i>						
Crude ash, . . . .	5.67	113.40	-	-		
" cellulose, . . . .	8.04	16.08	41.80	26		
" fat, . . . .	7.40	148.00	134.68	91		
" protein (nitrogenous matter), . . . .	37.15	743.00	646.41	87		
Non-nitrogenous extract matter, . . . .	41.74	834.80	759.67	91		
	100.00	2,000.00	1,582.56	-		

*Analysing Constituents of Old Process Linseed Meal.*

	Per Cent.
° C., . . . . .	7.480
. . . . .	.671
de, . . . . .	.827
. . . . .	.060
e (4½ cents per pound), . . . . .	1.379
(6 cents per pound), . . . . .	1.548
nts per pound), . . . . .	5.508
r, . . . . .	.214
on, . . . . .	\$21 76

*New Process Linseed Meal (Coarse).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
° C., . . . . .	6.01	120.20	—	—	} 1:1.32
. . . . .	93.99	1,879.80	—	—	
	100.00	2,000.00	—	—	
<i>Dry Matter.</i>					
. . . . .	6.04	120.80	—	—	
. . . . .	9.23	184.60	48.00	26	
. . . . .	3.14	62.80	57.15	91	
nitrogenous	40.76	815.20	709.22	87	
s extract	40.83	816.60	743.11	91	
	100.00	2,000.00	1,557.48	—	

*Analysing Constituents of New Process Linseed Meal.*

	Per Cent.
° C., . . . . .	6.010
. . . . .	.552
de, . . . . .	.534
. . . . .	.047
e (4½ cents per pound), . . . . .	1.517
(6 cents per pound), . . . . .	1.651
nts per pound), . . . . .	6.112
r, . . . . .	.192
on, . . . . .	\$24 05

*Linseed Meal.*

[I., new process, sent on by T. P. Root, Barre, Mass.; II., old process, sent on by  
S. P. Puffer, North Amherst, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	8.58	10.43
Dry matter, . . . . .	91.42	89.57
	100.00	100.00
<i>Analysis of Dry Matter.</i>		
Crude ash, . . . . .	7.52	8.37
“ cellulose, . . . . .	10.31	9.69
“ fat, . . . . .	3.18	6.24
“ protein (nitrogenous matter), . . . . .	32.50	30.98
Non-nitrogenous extract matter, . . . . .	46.49	44.72
	100.00	100.00

*Fine Feed.*

[Sent on by T. P. Root, Barre, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	7.7
Dry matter, . . . . .	92.2
	100.0
<i>Analysis of Dry Matter.</i>	
Crude ash, . . . . .	4.6
“ cellulose, . . . . .	5.8
“ fat, . . . . .	5.5
“ protein (nitrogenous matter), . . . . .	21.5
Non-nitrogenous extract matter, . . . . .	62.4
	100.0

*Barley Meal.*

[Springfield, Mass.]

86 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
° C., . . .	12.19	243.80	-	-	1 : 8.53
. . . . .	87.81	1,756.20	-	-	
	100.00	2,000.00	-	-	
<i>Dry Matter.</i>					
. . . . .	1.82	36.40	-	-	
. . . . .	7.37	147.40	17.69	12	
. . . . .	2.19	43.80	29.78	68	
nitrogenous					
, . . . .	11.17	223.40	174.25	78	
s extract					
. . . . .	77.45	1,549.00	1,394.10	90	
	100.00	2,000.00	1,615.82	-	

*Barley Meal.*

[Springfield, Mass.]

71 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
° C., . . .	13.61	272.20	-	-	1 : 9.11
. . . . .	86.39	1,727.80	-	-	
	100.00	2,000.00	-	-	
<i>Dry Matter.</i>					
. . . . .	2.79	55.80	-	-	
. . . . .	6.85	137.00	16.44	12	
. . . . .	1.69	33.80	22.95	68	
nitrogenous					
, . . . .	10.42	208.40	162.55	78	
s extract					
. . . . .	78.25	1,565.00	1,408.50	90	
	100.00	2,000.00	1,610.44	-	

*White Soja Beans.*

[Bought in New York.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . . .	5.85	117.00	-	-	1 : 1.97
Dry matter, . . . . .	94.15	1,883.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	5.57	111.40	-	-	
" cellulose, . . . . .	5.15	103.00	14.94	14.5	
" fat, . . . . .	18.42	368.40	330.82	89.8	
" protein (nitrogenous matter), . . . . .	35.98	719.60	647.64	90.0	
Non-nitrogenous extract matter, . . . . .	34.88	697.60	432.51	62.0	
	100.00	2,000.00	1,425.91	-	

*White Soja Beans.*

[Experiment Station, 1888.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	17.38	347.60	-	-	1 : 2.37
Dry matter, . . . . .	82.62	1,652.40	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	5.22	104.40	-	-	
" cellulose, . . . . .	5.35	107.00	15.52	14.5	
" fat, . . . . .	21.89	437.80	393.74	89.8	
" protein (nitrogenous matter), . . . . .	33.36	667.20	600.48	90.0	
Non-nitrogenous extract matter, . . . . .	34.18	683.60	423.83	62.0	
	100.00	2,000.00	1,432.97	-	

*Fertilizing Constituents of White Soja Beans.*

	Per Cent.
P C, . . . . .	17.380
. . . . .	.342
le, . . . . .	.869
. . . . .	.231
. . . . .	.166
(4½ cents per pound), . . . . .	2.085
(6 cents per pound), . . . . .	1.851
nts per pound), . . . . .	4.409
r, . . . . .	.090
on, . . . . .	\$18 98

*Black Soja Beans.*

[Experiment Station, 1888.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
P C., . . . . .	19.27	385.40	-	-	1:2.28
. . . . .	80.73	1,614.60	-	-	
	100.00	2,000.00	-	-	
ry Matter.					
. . . . .	6.73	134.60	-	-	
. . . . .	7.57	151.40	21.95	14 5	
. . . . .	20.25	405.00	363.69	89 8	
nitrogenous					
, . . . .	32.58	651.60	586.44	90.0	
s extract					
. . . . .	32.87	657.40	407.59	62.0	
	100.00	2,000.00	1,379.67	-	

*Fertilizing Constituents of Black Soja Beans.*

	Per Cent.
P C., . . . . .	19.270
. . . . .	.495
de, . . . . .	.949
. . . . .	.201
. . . . .	.384
e (4½ cents per pound), . . . . .	1.896
(6 cents per pound), . . . . .	1.886
nts per pound), . . . . .	4.208
r, . . . . .	.095
on, . . . . .	\$18 18



*Corn "Husks" or "Chaff."*

[Sent on by C. Brigham &amp; Co., Northborough, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	13.26
Dry matter, . . . . .	86.74
	<hr/>
	100.00
<i>Analysis of Dry Matter.</i>	
Crude ash, . . . . .	2.76
" cellulose, . . . . .	18.91
" fat, . . . . .	1.61
" protein (nitrogenous matter), . . . . .	5.61
Non-nitrogenous extract matter, . . . . .	71.11
	<hr/>
	100.00

1.55 per cent. passed screen 144 meshes to square inch.

*Corn "Germs."*

[Sent on by C. Brigham &amp; Co., Northborough, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	13.02
Dry matter, . . . . .	86.98
	<hr/>
	100.00
<i>Analysis of Dry Matter.</i>	
Crude ash, . . . . .	3.09
" cellulose, . . . . .	2.25
" fat, . . . . .	6.01
" protein (nitrogenous matter), . . . . .	11.20
Non-nitrogenous extract matter, . . . . .	77.45
	<hr/>
	100.00

46.77 per cent. passed screen 144 meshes to square inch.

*Low Meadow Hay.*

[Sent on by S. N. Thompson, Southborough, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	8.01
Dry matter, . . . . .	91.99
	<hr/>
	100.00
<i>Analysis of Dry Matter.</i>	
Crude ash, . . . . .	6.75
" cellulose, . . . . .	35.59
" fat, . . . . .	1.88
" protein (nitrogenous matter), . . . . .	9.51
Non-nitrogenous extract matter, . . . . .	46.27
	<hr/>
	100.00

*Corn Stover.*

[Sent on by J. C. Dillon, Amherst, Mass.]

	Per Cent.	
	I.	II.
C., . . . . .	15.60	17.22
. . . . .	84.40	82.78
	100.00	100.00
<i>Analysis of Dry Matter.</i>		
. . . . .	8.00	4.53
. . . . .	38.24	28.41
. . . . .	1.17	1.41
(nitrogenous matter), . . . .	7.94	6.07
extract matter, . . . . .	44.65	60.08
	100.00	100.00

*Ensilage.*

by J. N. Raymond, Beverly, Mass.; III. sent on by B. C. Haskell, Boston, Mass.]

	Per Cent.		
	I.	II.	III.
C., . . . . .	80.77	78.98	79.73
. . . . .	19.23	21.02	20.27
	100.00	100.00	100.00
<i>Analysis of Dry Matter.</i>			
. . . . .	5.08	4.71	3.19
. . . . .	33.99	33.79	28.43
. . . . .	2.71	1.94	3.60
(nitrogenous matter), . . . .	10.26	7.74	7.49
extract matter, . . . . .	47.96	51.82	57.29
	100.00	100.00	100.00

*Barley and Oat Chaff.*

[Sent on from Amherst, Mass.]

	Per Cent.
C., . . . . .	13.49
. . . . .	86.51
	100.00

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*Analysis of Dry Matter.*

	Per Cent.
Crude ash, . . . . .	10.41
“ cellulose, . . . . .	24.30
“ fat, . . . . .	2.40
“ protein (nitrogenous matter), . . . . .	11.78
Non-nitrogenous extract matter, . . . . .	51.11
	100.00

*Fertilizing Constituents of Barley and Oat Chaff.*

Moisture at 100° C., . . . . .	18.490
Calcium oxide, . . . . .	.853
Magnesium oxide, . . . . .	.346
Ferric oxide, . . . . .	.072
Sodium oxide, . . . . .	.035
Potassium oxide (4½ cents per pound), . . . . .	1.146
Phosphoric acid (6 cents per pound), . . . . .	.408
Nitrogen (17 cents per pound), . . . . .	1.650
Insoluble matter, . . . . .	.271
Valuation per ton, . . . . .	\$7 07

*Soja Bean (Entire Plant).*

[Collected Aug. 26, 1889.]

	Per Cent.
Moisture at 100° C., . . . . .	6.41
Dry matter, . . . . .	93.59
	100.00

*Analysis of Dry Matter.*

Crude ash, . . . . .	8.5
“ cellulose, . . . . .	21.7
“ fat, . . . . .	6.3
“ protein (nitrogenous matter), . . . . .	15.1
Non-nitrogenous extract matter, . . . . .	48.2
	100.0

In green material, moisture, 73.43 per cent. ; dry matter, 26.57 per cent.

*Fertilizing Constituents of Soja Bean.*

Moisture at 100° C., . . . . .	6.48
Calcium oxide, . . . . .	2.75
Magnesium oxide, . . . . .	1.16
Ferric oxide, . . . . .	.09
Sodium oxide, . . . . .	.09
Potassium oxide (4½ cents per pound), . . . . .	1.54
Phosphoric acid (6 cents per pound), . . . . .	.58
Nitrogen (17 cents per pound), . . . . .	2.25
Insoluble matter, . . . . .	.98
Valuation per ton, . . . . .	\$9 61

*Spanish or Long Moss (Tillandsia usneoides).*

	Per Cent.
C., . . . . .	60.80
. . . . .	39.20
	<hr/> 100.00

*Analysis of Dry Matter.*

. . . . .	2.67
. . . . .	32.61
. . . . .	2.54
(nitrogenous matter), . . . . .	4.45
extract matter, . . . . .	57.73
	<hr/> 100.00

*Fertilizing Constituents of Spanish Moss.*

C., . . . . .	60.80
. . . . .	.089
. . . . .	.122
anic oxides, . . . . .	.029
. . . . .	.263
(4½ cents per pound), . . . . .	.255
(6 cents per pound), . . . . .	.030
(8 cents per pound), . . . . .	.279
. . . . .	.191
. . . . .	\$1 21

*Palmetto Root.*

[Sent on by C. D. Duncan, Mandarin, Fla.]

	Per Cent.
C., . . . . .	11.51
. . . . .	88.49
	<hr/> 100.00

*Analysis of Dry Matter.*

. . . . .	4.44
. . . . .	21 26
. . . . .	.53
(nitrogenous matter), . . . . .	3.82
extract matter, . . . . .	69.95
	<hr/> 100.00
atter), . . . . .	49.84
. . . . .	Trace.
. . . . .	Trace.

*Fertilizing Constituents of Palmetto Root.*

C., . . . . .	11.510
. . . . .	3.930
. . . . .	.045

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	Per Ce
Magnesium oxide, . . . . .	.0
Ferric oxide, . . . . .	.0
Sodium oxide, . . . . .	.3
Potassium oxide (4½ cents per pound), . . . . .	1.3
Phosphoric acid (6 cents per pound), . . . . .	.1
Nitrogen (17 cents per pound), . . . . .	.5
Insoluble matter, . . . . .	.4
Valuation per ton, . . . . .	\$3

## Result of Examination of Fifty-pound Samples of the Corn entered by Competitors in This State for the American Agriculturist Prize.

### 1. Proportion of Moisture, Kernels and Cobs.

NAME AND ADDRESS OF COMPETITORS.	PER CENT. OF COMPOSITION.			PER CENT. OF MOISTURE.		RATIO OF COBS TO KERNELS.	
	Water.	Kernels	Cobs.	Kernels	Cobs.	As Received.	At 100°
1. W. S. Westcott, Amherst, . . . . .	31.30	58.88	9.82	23.26	57.38	1 : 3.00	1 : 5.
2. J. C. Dillon, Amherst, . . . . .	40.74	52.30	6.96	33.50	67.40	1 : 3.96	1 : 7.
3. F. Goodwin, Framingham, . . . . .	32.59	59.17	8.24	29.87	46.12	1 : 4.23	1 : 7.
4. J. S. Wells, Hatfield, . . . . .	37.28	54.66	8.06	38.49	54.77	1 : 3.60	1 : 6.
5. Henry Tillson, Sunderland, . . . . .	32.02	58.46	9.52	28.75	46.96	1 : 5.61	1 : 6.
6. G. P. Smith, Sunderland, . . . . .	30.31	59.29	10.40	22.36	56.00	1 : 3.53	1 : 5.
7. John Brooks, Princeton, . . . . .	28.27	61.46	10.27	24.98	45.75	1 : 3.62	1 : 6.
Averages, . . . . .	33.22	57.74	9.03	28.15	53.48	1 : 4.02	1 : 6.

### 2. Description of Ears.

KIND OF CORN.	Number of Ears.	AVERAGE WEIGHT OF EARS (GRAMS).		AVERAGE WEIGHT OF KERNELS (GRAMS).		Average Length
		As Received.	At 100° C.	As Received	At 100° C.	
1. Yellow Flint, . . . . .	125	177.4	121.9	.368	.281	8½
2. Yellow Dent, . . . . .	96	222.9	132.1	.297	.197	7½
3. Yellow Flint, . . . . .	102	209.8	141.8	.452	.317	9½
4. Yellow Dent, . . . . .	67	319.4	200.3	.452	.300	8½
5. Yellow Dent, . . . . .	129	173.6	118.0	.384	.273	6½
6. Yellow and White Flint, .	115	194.7	135.7	.457	.355	9½
7. White Flint, . . . . .	135	167.9	120.5	.415	.312	8
Averages, . . . . .	110	209.4	139.9	.404	.291	8½

*Fodder Constituents in Kernels (Per Cent.).*

Moisture at 100° C.	Dry Matter.	ANALYSIS OF DRY MATTER.					Nutritive Ratio.
		Crude Ash.	Crude Cellulose.	Crude Fat.	Crude Protein (Nitrogenous Matter).	Non-nitrogenous Extract Matter.	
23.26	76.74	1.77	1.07	4.60	8.49	83.98	1: 12.22
23.50	66.50	1.65	1.40	4.42	9.37	83.16	1: 10.93
29.87	70.13	1.99	1.03	5.32	11.58	80.08	1: 8.72
23.49	66.51	1.95	1.51	5.45	11.14	79.95	1: 9.08
28.75	71.25	1.19	1.71	5.09	9.27	82.74	1: 11.17
22.36	77.64	1.44	1.36	4.96	13.36	78.88	1: 7.40
24.98	75.02	2.09	1.27	5.28	12.27	79.09	1: 8.45
28.03	71.97	1.73	1.33	5.03	10.78	81.13	1: 9.71

*Per Cent. of Digestibility of Constituents.*

Cellulose, . . . . .	34
Protein, . . . . .	76
Starch, . . . . .	85
Non-nitrogenous extract matter, . . . . .	94

*Valuing Constituents in Dry Matter (Per Cent.).*

	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Sodium Oxide.	Potassium Oxide.	Phosphoric Acid.	Nitrogen.	Insoluble Matter.	Valuation per 2,000 Pounds Dry Mat- ter.
..	.028	.200	.017	.033	.274	.624	1.35	.040	\$5.57
..	.114	.193	.054	.025	.318	.845	1.49	.032	6.35
..	.036	.222	.022	.038	.349	.772	1.85	.038	7.52
..	.027	.169	.015	.023	.389	.492	1.78	.018	6.67
..	.026	.164	.009	.028	.342	.457	1.49	.009	5.91
..	.034	.231	.041	.028	.462	.638	1.97	.013	7.80
..	.022	.264	.020	.031	.407	.859	1.96	.020	8.03
..	.041	.206	.025	.029	.363	.670	1.70	.024	\$6.85

cents per pound; phosphoric acid, 6 cents; nitrogen, 17 cents.

## ON FIELD EXPERIMENTS.

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I. Field experiments to compare the influence of an addition of nitrogen in different combinations to the soil under cultivation on the general character of the crop and on the annual yield.

II. Influence of fertilizers on the quantity and quality prominent fodder crops.

III. Experiments with field and garden crops.

IV. Experiments with green crops for summer feed of milch cows.

V. Notes on miscellaneous field work.

VI. Prof. James E. Humphrey's report on fungi, etc.

### I. FIELD EXPERIMENTS TO COMPARE THE INFLUENCE OF AN ADDITION OF NITROGEN IN DIFFERENT COMBINATIONS TO THE SOIL UNDER CULTIVATION, ON THE GENERAL CHARACTER OF THE CROP AND ON THE ANNUAL YIELD. (FIELD A.)

The area assigned to this investigation is the same which has been used in preceding years to study our lands with reference to the conditions of the inherent natural resources of potash. The previous system of subdivision into plots one-tenth of one acre in size, is retained in all its details. The record of each plot, as far as modes of cultivation and of manuring are concerned, extends over more than fifty successive years. This circumstance served as one of the inducements to undertake the above-stated task.

Some plots had received during that period a supply of nitrogen for manurial purposes in but one and the same specified form, while others had received none in any form. This condition of the various plots was turned to proper account in our new plans. Several plots which for fifty preceding years did not receive any nitrogen compound for manurial purposes, were retained in that state to study the effect of an entire exclusion of nitrogen-containing manurial substances on the crop under cultivation; while the remaining ones received, as before, a definite amount of nitrogen in the same form in which they had received it in preceding years, namely, either as sodium nitrate or as ammonium sulphate, or as organic nitrogenous matter in form of dried

corresponding amount of available nitrogen was in these cases.

the difference regarding the nitrogen supply, were treated alike. They each received, without a corresponding amount of available phosphorus of potassium oxide. The phosphoric acid was in form of dissolved bone-black, and the nitrogen either in form of muriate of potash or of sodium sulphate. From 120 to 130 pounds of potassium oxide, from 80 to 85 pounds of available phosphorus and from 40 to 50 pounds of available nitrogen, per acre.

Plot marked 0, received its main supply of phosphorus, potassium oxide and nitrogen in form of barn-yard manure. The latter was carefully analyzed before being used to determine the amount required to secure, as far as possible, the desired corresponding proportion of the fertilizing constituents. The deficiency in potassium was supplied by potash-magnesia dissolved bone-black. The fertilizer for this plot consisted of 800 pounds of barn-yard manure, 32 pounds of potassium sulphate, and 18 pounds of dissolved

Plot 9 received no nitrogen-containing manurial substances. Plots 1 and 2 received nitrogen in form of sodium nitrate. Plots 5, 6 and 8 received nitrogen in form of ammonium sulphate; plots 3 and 10 received nitrogen in form of sodium nitrate. Plot 0 received nitrogen in form of barn-yard manure.

To compare the following tables, containing the results of the experiment on field A : —

*Composition of Manurial Substances applied.*

	Per Cent.
Nitrogen, . . . . .	16.00
Ammonia = nitrogen, . . . . .	20.91
Nitrogen, . . . . .	8.24
Potash = potassium oxide, . . . . .	48.58
Potash = potassium oxide, . . . . .	37.54
Bone-black = available phosphoric acid, . . . . .	21.80
Moisture, . . . . .	73.04
phosphoric acid, . . . . .	.688
potassium oxide, . . . . .	.527
nitrogen, . . . . .	.568



## Field A.

[1882, a meadow; 1883, planted with "Longfellow" corn; 1884, 1885, 1886, 1887, 1888, 1889, planted with "Clark" corn.]

NUMBER OF PLAT.	FERTILIZERS APPLIED.			YIELD OF DRY FODDER CORN.		
	1885.	1886.	1887.	1885.	1886.	1887.
Plat 1,	25 lbs. sodium nitrate (= 4 lbs. nitrogen).	50 lbs. sodium nitrate (= 7 to 8 lbs. nitrogen).	50 lbs. sodium nitrate (= 7 to 8 lbs. nitrogen) and 50 lbs. muriate of potash (= 25 lbs. potassium oxide), . . . . .	Lbs.	Lbs.	Lbs.
Plat 2,	Nothing, . . . . .	Nothing, . . . . .	Nothing, . . . . .	480	430	720
Plat 3,	30 lbs. dried blood (= 4 lbs. nitrogen).	60 lbs. dried blood (= 7 to 8 lbs. nitrogen).	60 lbs. dried blood (= 7 to 8 lbs. nitrogen) and 100 lbs. dissolved bone-black (= 17 lbs. available phosphoric acid), . . . . .	310	250	165
Plat 4,	Nothing, . . . . .	Nothing, . . . . .	Nothing, . . . . .	360	310	240
Plat 5,	25 lbs. ammonium sulphate (= 5 lbs. nitrogen).	50 lbs. ammonium sulphate (= 10 lbs. nitrogen).	50 lbs. ammonium sulphate (= 10 lbs. nitrogen) and 97 lbs. potash-magnesia sulphate (= 25 lbs. potassium oxide), . . . . .	300	250	130
Plat 6,	Fallow, . . . . .	Fallow, . . . . .	Fallow, . . . . .	360	280	635
Plat 7,	50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).	100 lbs. dissolved bone-black (= 17 lbs. available phosphoric acid).	100 lbs. dissolved bone-black (= 17 lbs. available phosphoric acid) and 50 lbs. muriate of potash (= 25 lbs. potassium oxide), . . . . .	-	-	-
Plat 8,	Nothing, . . . . .	Nothing, . . . . .	Nothing, . . . . .	280	255	730
Plat 9,	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide).	50 lbs. muriate of potash (= 25 lbs. potassium oxide).	50 lbs. muriate of potash (= 25 lbs. potassium oxide), . . . . .	250	195	165
Plat 10,	45 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide).	97 lbs. potash-magnesia sulphate (= 25 lbs. potassium oxide).	97 lbs. potash-magnesia sulphate (= 25 lbs. potassium oxide) and 60 lbs. dried blood (= 7 to 8 lbs. nitrogen), . . . . .	945	840	655
				845	885	940

Plat 2,	50 lbs. nitrate of soda (= 7 to 8 lbs. nitrogen),	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	617	643
Plat 3,	100 lbs. dissolved bone-black (= 17 lbs. available phosphoric acid).	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	303	577
Plat 4,	Nothing,	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	150	618
Plat 5,	97 lbs. magnesium sulphate,	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	114	381
Plat 6,	Nothing,	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	564	488
Plat 7,	50 lbs. muriate of potash (= 25 lbs. potassium oxide),	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	193	542
Plat 8,	50 lbs. ammonium sulphate (= 10 lbs. nitrogen),	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	676	528
Plat 9,	50 lbs. muriate of potash (= 25 lbs. potassium oxide),	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	146	359
Plat 10,	97 lbs. potash-magnesia sulphate (= 25 lbs. potassium oxide) and 50 lbs. dried blood (= 7 to 8 lbs. nitrogen).	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	553	476
,			737	640

The entire field, eleven plats, was ploughed April 9. The fertilizer was applied broadcast to each plat, and subsequently slightly harrowed under, April 27. The final preparation of the soil for seeding, by ploughing and harrowing, took place May 9. The same variety of corn (Clark), a flint corn, was planted in drills in a similar manner as during preceding years, May 10. The crop on all plats was kept clean by means of the cultivator and hoe; it was cut September 3, when the kernels were fairly glazed over. The degree of progress in the growth of the corn upon different plats during the entire season may be noticed from the following tabular statement of periodical measurements of their average heights:—

*Height of Corn on Plats, in Inches (1889).*

	June 11.	June 19.	June 26.	July 3.	July 10.	July 17.	July 24.	July 31.	Aug. 7.	Aug. 14.	Aug. 21.	Aug. 28.
Plat 0, .	6	9	11	18	25	35	45	64	70	73	73	73
Plat 1, .	6	9	12	16	26	36	44	64	73	73	73	73
Plat 2, .	6	7½	10	15	25	33	42	62	69	70	70	72
Plat 3, .	6½	9	12	14	24	31	41	60	68	73	73	75
Plat 4, .	5½	7	10	13	20	27	33	49	62	65	65	67
Plat 5, .	5½	7½	10	13	23	34	41	55	67	70	70	70
Plat 6, .	6	8	9½	13	20	30	40	61	66	74	74	74
Plat 7, .	6	10	13	16	26	40	48	60	64	68	70	70
Plat 8, .	5	6½	8	10	17	21	30	45	54	60	62	68
Plat 9, .	6	9	10	16	22	33	41	60	63	68	69	69
Plat 10, .	7	11	14	19	27	46	54	69	75	76	76	76

The marked difference in the general appearance of the corn crop on different plats during the various stages of its growth was, however, not confined to their varying heights; they differed also at times much in regard to a more or less healthy color. The growth upon plats 7 and 9, in particular, was, during the entire season, of a light-green color; the same feature was noticeable to some degree, during the first half of the season, on plats 4, 5, 6 and 8. Upon the remaining plats the color was deep green, indicating a vigorous condition. Plats 4, 7 and 9 received no nitrogen-containing manurial substance; plats 5, 6 and 8 received an addition

in form of ammonium sulphate, and the remainder either of dried blood or of sodium nitrate. The noticeable difference is the character of the ears. Those plats (4, 7 and 9) which received no fertilizer applied, produced not only by far the largest quantity of ears, but also the smallest number of undeveloped ears. The yield in corn stover, on the other hand, is, in two of these cases (7 and 9) at least, the highest on any of the other plats, as may be seen in the following record:—

*Stover and Ears on Plats (1889), at Forty-eight Per Cent. Moisture.*

	Weight of Whole Crop.	Weight of Stover.	Weight of Ears.
	Lbs.	Lbs.	Lbs.
1	500.62	342.35	158.27
2	648.49	475.95	172.53
3	576.91	375.75	201.16
4	618.31	425.85	192.46
5	381.18	283.90	97.28
6	488.01	359.05	128.96
7	541.95	367.05	174.90
8	525.82	484.30	41.52
9	359.12	237.98	121.14
10	475.63	417.50	58.13
11	639.55	467.60	171.95

*Well-developed and Undeveloped Ears on Plats (1889).*

	Well-developed Ears.	Undeveloped Ears.
	Per Cent.	Per Cent.
1	60.3	39.7
2	48.5	51.5
3	46.7	53.3
4	28.3	71.7
5	14.7	85.3
6	18.7	81.3
7	29.0	71.0
8	41.6	58.4
9	21.3	78.7
10	24.4	75.6
11	50.2	49.8

The results of our first season of observation regarding the influence of nitrogen-containing manurial substances on the character and on the quantity of the fodder corn raised under otherwise corresponding circumstances, although not without some interest, are not decisive enough to advise a detailed explanation of causes. The larger part of the late summer season with us was cold and wet, and for this reason of an exceptionally unfavorable character for the raising of fodder corn. How much this circumstance has affected our results, is difficult to decide. Not less difficult is it to decide, at this stage of observation, how much the special conditions of various plats may yet control the results. The experiment will be continued until a reliable basis for a final conclusion has been secured.

10	43 lbs. Dried Blood. 48½ lbs. Potash Magnesia Sul. 50 lbs. Dis. Bone Black.
9	25 lbs. Muriate of Potash. 50 lbs. Dis. Bone Black.
8	22½ lbs. Sulphate Ammonia. 25 lbs. Muriate of Potash. 50 lbs. Dis. Bone Black.
7	25 lbs. Muriate of Potash. 50 lbs. Dis. Bone Black.
6	22½ lbs. Sulphate Ammonia. 25 lbs. Muriate of Potash. 50 lbs. Dis. Bone Black.
5	22½ lbs. Sulphate Ammonia. 48½ lbs. Potash Magnesia Sul. 50 lbs. Dis. Bone Black.
4	25 lbs. Muriate Potash. 50 lbs. Dis. Bone Black.
3	43 lbs. Dried Blood. 25 lbs. Muriate of Potash. 50 lbs. Dis. Bone Black.
2	29 lbs. Nitrate of Soda. 48½ lbs. Potash Magnesia Sul. 50 lbs. Dis. Bone Black.
1	29 lbs. Nitrate of Soda. 25 lbs. Muriate of Potash. 50 lbs. Dis. Bone Black.
0	800 lbs. Barnyard Manure. 52 lbs. Potash Magnesia Sul. 18 lbs. Dis. Bone Black.

SCALE, 4 RODS TO 1 INCH.

CORN PLATS WITH DRAINAGE SYSTEM.

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## II. INFLUENCE OF FERTILIZERS ON THE QUANTITY AND QUALITY OF PROMINENT FODDER CROPS. (FIELD B.)

The field is located west of Field A, and has been used, like the latter, for several years previous to the establishment of the experiment station, for the production of hay. The land is nearly on a level, and runs from north to south; it occupies at the present time an area of 1.7 acres. The soil consists of a somewhat sandy loam. In 1884 the entire field was subdivided into eleven plats of equal size, with five feet of space between them. Every alternate plat has received from that date annually the same kind and the same amount of fertilizer, — six hundred pounds of ground bones, and two hundred pounds of muriate of potash per acre. Since 1885 all crops on that field have been raised in rows; this system of cultivation became a necessity in the case of grasses, clovers, etc., to secure a clean crop for observation. The rows, in the case of corn and leguminous plants, were three feet and three inches apart; and, in the case of grasses, two feet. The space between the different plats has received, thus far, no manurial substance of any description, and is kept clean from vegetation by a proper use of the cultivator. Plats 11, 13, 15, 17, 19 and 21 were fertilized annually; plats 12, 14, 16, 18 and 20 have received no fertilizer until the present season, — 1889.

The details of the work carried on upon Field B are from year to year recorded in the annual report of the station. As the chemical analyses of the crops raised require considerable time, on account of other contemporary pressing engagements in the laboratory, they are usually published in bulletins, and the reports of the succeeding year.

The subsequent tabular statement of crops raised upon the different plats of Field B since 1886 may assist in a desirable understanding of its late history, and its condition at the beginning of the season of 1889. The single plats are, since 1886, each 175 feet long and 33 feet wide.

PLANT.

1897.

1898.

1899.

Plat 11 (fertilized), .	Corn, . . . . .	Kentucky blue-grass ( <i>Poa pratensis</i> ),	Kentucky blue-grass.
Plat 12 (unfertilized), .	Corn, . . . . .	Kentucky blue-grass, . . . . .	Kentucky blue-grass (fertilized August, 1899).
Plat 13 (fertilized), .	{ Italian rye-grass ( <i>Lolium italicum</i> ), .	Italian rye-grass, . . . . .	Red-cob ensilage corn.
Plat 14 (unfertilized), .	{ English rye-grass ( <i>Lolium perenne</i> ), .	English rye-grass, . . . . .	Red-cob ensilage corn (fertilized May, 1899).
Plat 15 (fertilized), .	{ Italian rye-grass, . . . . .	Italian rye-grass, . . . . .	{ Bokhara clover ( <i>Medicago alba</i> ).
	{ English rye-grass, . . . . .	English rye-grass, . . . . .	{ Sainfoin ( <i>Onobrychis sativa</i> ).
	{ Five varieties Southern cow-pea, . . . . .	Soja bean ( <i>Soja hispida</i> ), . . . . .	{ Bokhara clover (fertilized May, 1899).
Plat 16 (unfertilized), .	{ Five varieties Southern cow-pea, . . . . .	Soja bean, . . . . .	{ Sainfoin (fertilized May, 1899).
Plat 17 (fertilized), .	Meadow fescue ( <i>Festuca pratensis</i> ), . . . . .	Meadow fescue, . . . . .	Meadow fescue.
Plat 18 (unfertilized), .	{ Alsike clover ( <i>Trifolium hybridum</i> ), .	Alsike clover, . . . . .	Red-cob ensilage corn (fertilized May, 1899).
	{ Medium red clover ( <i>Trifolium pratense</i> ), .	Medium red clover, . . . . .	Alsike clover.
Plat 19 (fertilized), .	{ Alsike clover, . . . . .	Alsike clover, . . . . .	Medium red clover.
	{ Medium red clover, . . . . .	Medium red clover, . . . . .	Red-cob ensilage corn (fertilized May, 1899).
Plat 20 (unfertilized), .	{ Mammoth red clover ( <i>Trifolium medium</i> ), .	Mammoth red clover, . . . . .	Corn (variety, Clark).
	{ Alfalfa or lucerne ( <i>Medicago sativa</i> ), .	Alfalfa, . . . . .	
Plat 21 (fertilized), .	{ Mammoth red clover, . . . . .	Mammoth red clover, . . . . .	
	{ Alfalfa, . . . . .	Alfalfa, . . . . .	

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1889. — The general appearance of the plats seeded in preceding years with perennial varieties of grasses and leguminous plants presented some interesting features at the opening of the late season. Some crops had suffered seriously from winter-killing, while others had passed unharmed through the winter. Wherever the growth suffered, the fact showed itself invariably in the most serious degree upon unfertilized plats.

*Kentucky blue-grass*, Plat 11 (fertilized), was well preserved; the same circumstance was noticed on Plat 12 (unfertilized).

*Perennial rye-grass*, plats 13 and 14 (fertilized and unfertilized), was dead in the rows.

*Italian rye-grass* was fairly preserved in the rows on all the plats.

*Meadow fescue*, Plat 17 (fertilized), was in a healthy and well-preserved condition.

*Alsike clover*, plats 18 and 19 (unfertilized and fertilized), had suffered somewhat on the unfertilized plat, but was well preserved upon the fertilized plat (19).

*Medium red clover*, raised on the same plats as the *Alsike*, was in better condition upon the unfertilized plat (18) than the latter, yet fell behind on the fertilized plat (19).

*Alfalfa*, plats 20 and 21 (unfertilized and fertilized), were almost entirely winter-killed. The same feature was noticeable in regard to mammoth red clover, upon the unfertilized Plat 20, while upon Plat 21 (fertilized) a fair growth was noticed. The plats 15 and 16, which had been used in the preceding season for the production of Soja beans, were ploughed and prepared for seeding; the same course was pursued in regard to the grass and clover plats, where the growth had been seriously winter-killed, — plats 18, 19, and 21.

Plats 12, 14, 16, 18 and 20, which for five preceding years had not been fertilized, were treated, like all fertilized plats in this field, with eighty pounds of fine-ground bone and twenty-seven pounds of muriate of potash per acre.

Plats 15 and 16 were turned to account for the cultivation of Bokhara clover (*Melilotus alba*) and of sainfoin (*Ononis chis sativa*). Each plat was subdivided into two equal

seeded down, one-half with Bokhara clover and half with sainfoin, May 8.

Plats 14, 18 and 20 were planted, May 27, with red-corn, a dent variety sent on for trial by Messrs. Fell & Co. of St. Louis. Nine quarts of corn for that purpose. Plat 21 was planted on the 14th with two and one-half quarts of Clark corn, a flint medium size.

Plats of clover and sainfoin varieties were kept clean from the use of the cultivator and the hoe; a similar treatment was bestowed upon the corn-bearing plats.

Blue-grass, seeded down in 1888, proved to be a mixture of other grasses, herd's grass in particular. The grass on both plats was cut for hay June 1 (fertilized) yielded 520 pounds of hay, or 520 pounds per acre; Plat 12 (unfertilized) yielded 280 pounds of hay, or 2,111 pounds per acre. The sod was turned under, and both plats re-seeded with blue-grass, September, 1889.

Rescue, Plat 17, began to head out May 30; it was cut June 4; it was thirty-six inches high when in full. The cutting had to be deferred, on account of the weather, to June 20, when it measured forty-four inches high. The first cut of hay weighed 560 pounds, or 560 pounds per acre; the second cut (rowen) of hay, June 24, weighed 290 pounds, or 2,187 pounds per acre. Blue-grass compares well in quality and quantity with Rescue; seeded down close, it forms a compact, fine sod.

Red-clover, Plat 15, was seeded May 8; it appeared June 10 and May 16; was eight inches high July 3, and ten inches August 7; it was cut for hay September 10, and yielded at the rate of 3,090 pounds per acre. The growth of Red-clover is usually much heavier; the plant in the end of the second year. The large yield of Red-clover, in particular during the second year, is a matter of observation with this plant for feeding purposes.

Plat 15, was seeded May 8; the young plants appeared above ground May 18; it measured four inches

July 3. The growth of the plant was very slow during the entire season. The land was cleaned from weeds September 24, and the crop left for another year's observation. Whether a cold and wet season caused this slow progress in the growth of this reputed fodder crop, has to be left for the future to decide.

Alsike clover, Plat 19, started up well in May; it was in full bloom June 3, and was cut for hay July 2. The clover hay weighed 155 pounds, or 2,400 pounds per acre.

Medium red clover, Plat 19, began blooming June 17, the crop was cut for hay July 12. The latter weighed 180 pounds, or 2,900 pounds per acre.

In the interest of a due appreciation of the annual yield stated in connection with the above-described grasses and clovers, attention is here once more called to the fact that all were raised in rows, and not broadcast. The rows were, in case of the grasses, for stated reasons, two feet apart, and in case of clovers three feet. The numerical statements regarding their annual yield are therefore mainly of interest as far as relative quantities are concerned. Taking this circumstance into due consideration, it will be conceded that the yield in some instances has been remarkably large; as, for instance, in the case of meadow fescue, — 4,422 pounds of hay in the first cut and 2,187 pounds in the second cut, or 6,609 pounds of hay per acre. On a previous occasion it has been already stated that the cultivation of grasses in drills has been adopted in our experiments, on account of the chances this system of cultivation offers to keep individual varieties of grasses free from foreign growth. The introduction of drill cultivation in connection with the raising of grain crops is deservedly urged upon the attention of farmers, in the interest of clean cultivation.

Red-cob ensilage corn, plats 13, 14, 18 and 20, was planted in drills with nine quarts of seed corn, May 25. The rows were three feet and three inches apart, and the kernels were dropped in the rows from twelve to fourteen inches apart, with from four to six seeds in a place. The entire field was subsequently kept clean from weeds by frequent use of the cultivator or the hoe, as circumstance

The young plants appeared above ground June 3. They looked vigorous and handsome throughout the season, yet was somewhat behind in its various stages.

The entire crop was cut for the silo September 10, although the ears were not yet as far advanced as to secure the full benefit of the season. Early in the season we cut our corn crops at the beginning of September. This feature of our local climate and selection of early-maturing varieties of corn. The crop secured from the different plats varied slightly, — a result apparently largely due to the condition of the soil with reference to temporary sources of plant food. The majority of plats (Plat 20) had not been fertilized for several preceding years. Plat 13 was the only one, planted with the stated corn, which for years had been fertilized with bone

One year's treatment, spring of 1889, with a large amount of these two manurial substances, to test their productiveness to its full capacity.

Yielded 5,820 lbs. green fodder corn, or 43,884 lbs. per acre.

4,755	"	"	"	"	35,853	"	"
3,230	"	"	"	"	24,354	"	"
2,560	"	"	"	"	19,302	"	"

Plat 21, was planted on the same date as the first, but was treated alike in all particulars; it did well throughout the season; it showed tassels July 19, and was cut for silo September 7. The crop was more matured than the first-cob ensilage corn, yet was the lowest in yield, 3,655 pounds per plat, or 17,832 pounds per acre. The main difference in the weight of the crops between the two varieties of corn does not express their relative value; yet the difference in that direction is so marked that it must be admitted that the Clark corn is not a silage corn.

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ANALYSES OF CROPS RAISED UPON FIELD B DURING THE SUMMER  
SEASON OF 1888.*Italian Rye Grass (1888).*

	COLLECTED JUNE 29, 1888 IN BLOOM.		COLLECTED JULY 16, 1888 IN SEED.	
	Fertilized.	Unfertilized.	Fertilized.	Unfertilized.
Moisture at 100° C, . . . .	9.30	8.96	8.22	7.3
Dry matter, . . . .	90.74	91.04	91.78	92.6
	100.00	100.00	100.00	100.0
<i>Analysis of Dry Matter.</i>				
Crude ash, . . . .	7.44	7.50	8.58	6.5
“ cellulose, . . . .	31.27	32.79	36.90	32.3
“ fat, . . . .	2.04	1.89	1.90	2.0
“ protein (nitrogenous matter), . . . .	9.75	7.13	9.53	6.2
Non-nitrogenous extract matter, . . . .	49.50	51.19	43.09	52.8
	100.00	100.00	100.00	100.0

*Fertilizing Constituents of Italian Rye Grass.*

	COLLECTED JUNE 29, 1888. IN BLOOM.		COLLECTED JULY 16, 1888. IN SEED.	
	Fertilized.	Unfertilized.	Fertilized.	Unfertilized.
Moisture at 100° C., . . . .	9.300	8.960	9.204	7.30
Calcium oxide, . . . .	.644	.639	.983	1.10
Magnesium oxide, . . . .	.357	.316	.328	.28
Ferric oxide, . . . .	.045	.042	.065	.11
Sodium oxide, . . . .	.151	.463	.795	.39
Potassium oxide (4½ cts. per lb.), . . . .	1.922	1.184	2.086	.94
Phosphoric acid (6 cts. per lb.), . . . .	.546	.572	.539	.56
Nitrogen (17 cts. per lb.), . . . .	1.415	1.039	1.381	.91
Insoluble matter, . . . .	1.922	2.602	2.290	3.50
Valuation per ton, . . . .	\$7 10	\$5 22	\$6 24	\$4 4

OF CROPS RAISED UPON FIELD B—*Continued.**Alsike Clover (1888).*

	COLLECTED JUNE 21, 1888, IN BLOOM.		COLLECTED JULY 18, 1888, IN SEED.
	Fertilized.	Unfertilized.	Fertilized.
° C., . . . . .	13.52	13 10	6.08
. . . . .	86.48	86.90	93.92
100.00	100.00	100.00	100.00
of Dry Matter.	15.91	9.90	8.26
. . . . .	26.79	24.03	32.34
. . . . .	2.19	1.88	3.07
(nitrogenous matter),	16.48	17.55	14.77
s extract matter,	38.63	46.64	41.56
100.00	100.00	100.00	100.00

*Fertilizing Constituents of Alsike Clover.*

	COLLECTED JUNE 21, 1888, IN BLOOM.		COLLECTED JULY 18, 1888, IN SEED.
	Fertilized.	Unfertilized.	Fertilized.
° C., . . . . .	13 520	13 100	6 080
. . . . .	2.119	2 608	2 838
de, . . . . .	.330	.705	.304
. . . . .	.141	.202	.064
. . . . .	.299	.273	.209
e, . . . . .	4.308	1.087	2.602
, . . . . .	.716	.704	.496
. . . . .	2.280	2.440	2.214
r, . . . . .	.744	1.102	.420
on, . . . . .	\$12 27	\$10 06	\$10 34

*Medium Red Clover (1888).*

[Collected July 6, 1888, in bloom, fertilized.]

° C., . . . . .	6.02
. . . . .	93.98
100.00	100.00

ANALYSES OF CROPS RAISED UPON FIELD B — *Continued.**Analysis of Dry Matter.*

Crude ash, . . . . .	8.9
" cellulose, . . . . .	29.9
" fat, . . . . .	2.6
" protein (nitrogenous matter), . . . . .	14.6
Non-nitrogenous extract matter, . . . . .	43.8
	100.0

*Fertilizing Constituents of the Above Medium Red Clover.*

Moisture at 100° C., . . . . .	6.0
Calcium oxide, . . . . .	1.9
Magnesium oxide, . . . . .	.4
Ferric oxide, . . . . .	.0
Sodium oxide, . . . . .	.2
Potassium oxide, . . . . .	2.3
Phosphoric acid, . . . . .	.4
Nitrogen, . . . . .	2.1
Insoluble matter, . . . . .	.2
Valuation per ton, . . . . .	\$9

*Mammoth Red Clover (1888).*

	COLLECTED JUNE 21, 1888, IN BLOOM.		COLLECTED JULY 13, 1888 IN SEED.
	Fertilized.	Unfertilized.	Unfertilized.
Moisture at 100° C., . . . . .	17.53	9.36	7.34
Dry matter, . . . . .	82.47	90.64	92.66
	100.00	100.00	100.00
<i>Analysis of Dry Matter.</i>			
Crude ash, . . . . .	10.50	10.50	8.53
" cellulose, . . . . .	33.72	20.16	28.65
" fat, . . . . .	2.25	1.86	2.25
" protein (nitrogenous matter), . . . . .	14.69	18.50	14.06
Non-nitrogenous extract matter, . . . . .	38.84	48.98	46.51
	100.00	100.00	100.00

OF CROPS RAISED UPON FIELD B—*Continued.**Fertilizing Constituents of Mammoth Red Clover.*

	COLLECTED JUNE 21, 1888, IN BLOOM.		COLLECTED JULY 23, 1888, IN SEED.
	Fertilized.	Unfertilized.	Unfertilized.
P C., . . . . .	17.530	9.360	7.340
le, . . . . .	2.732	3.978	2.712
. . . . .	.312	.792	.735
. . . . .	.057	.144	.133
. . . . .	.512	.558	.098
. . . . .	2.430	.726	.513
. . . . .	.504	.704	.421
. . . . .	1.938	2.680	2.075
. . . . .	.261	.908	1.168
on, . . . . .	\$9 26	\$10 57	\$8 00

*Alfalfa (1888).*

	COLLECTED JUNE 29, 1888, IN BLOOM.	
	Fertilized.	Unfertilized.
P C., . . . . .	4.68	4.60
. . . . .	95.32	95.40
. . . . .	100.00	100.00
<i>Analysis of Dry Matter.</i>		
. . . . .	7.97	7.10
. . . . .	34.39	32.41
. . . . .	1.12	1.04
(nitrogenous matter), . . . . .	16.27	14.41
extract matter, . . . . .	40.25	45.04
. . . . .	100.00	100.00



ANALYSES OF CROPS RAISED UPON FIELD B — *Concluded**Fertilizing Constituents of Alfalfa.*

	COLLECTED JUNE IN BLOOM	
	Fertilized.	Unfertilized.
Moisture at 100° C., . . . . .	4.680	
Calcium oxide, . . . . .	1.944	
Magnesium oxide, . . . . .	.279	
Ferric oxide, . . . . .	.050	
Sodium oxide, . . . . .	.079	
Potassium oxide, . . . . .	2.038	
Phosphoric acid, . . . . .	.556	
Nitrogen, . . . . .	2.481	
Insoluble matter, . . . . .	.140	
Valuation per ton, . . . . .	\$10 84	

*Soja Bean (Entire Plant, Dry).*

[Collected Aug. 30, 1888, unfertilized.]

Moisture at 100° C., . . . . .	
Dry matter, . . . . .	

*Analysis of Dry Matter.*

Crude ash, . . . . .	
“ cellulose, . . . . .	
“ fat, . . . . .	
“ protein (nitrogenous matter), . . . . .	
Non-nitrogenous extract matter, . . . . .	

*Fertilizing Constituents of the Above Soja Bean.*

Moisture at 100° C., . . . . .	
Calcium oxide, . . . . .	
Magnesium oxide, . . . . .	
Ferric oxide, . . . . .	
Sodium oxide, . . . . .	
Potassium oxide, . . . . .	
Phosphoric acid, . . . . .	
Nitrogen, . . . . .	
Insoluble matter, . . . . .	
Valuation per ton, . . . . .	

KENTUCKY BLUE GRASS. FERTILIZED.

KENTUCKY BLUE GRASS. UNFERTILIZED.

RED COB ENSILAGE CORN.  
FERTILIZED.

RED COB ENSILAGE CORN.  
FERTILIZED.

KHARA CLOVER.  
IN FOIN. FERTILIZED.

KHARA CLOVER.  
IN FOIN. UNFERTILIZED.

MEADOW FESCUE. FERTILIZED.

RED COB ENSILAGE CORN.  
FERTILIZED.

MEDIUM RED CLOVER.  
SIKE CLOVER. FERTILIZED.

RED COB ENSILAGE CORN.  
FERTILIZED.

MARK CORN. FERTILIZED.

SCALE, 4 RODS TO 1 INCH.

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### III. EXPERIMENTS WITH FIELD AND GARDEN CROPS (FIELDS C AND D, 1889.)

A short description of the work carried on upon these fields during the preceding year, 1888, may serve as an introduction to a brief statement of the course adopted in 1889.

*Field C, 1888.*—This field comprises an area 328 feet long and 183 feet wide. It was ploughed the previous fall and again April 26; it was harrowed soon after, and fertilized broadcast at the rate of six hundred pounds of fine-ground bones and two hundred pounds of muriate of potash per acre. The field is divided into two parts, running from east to west; they are separated from each other by a passageway three feet wide. The northern half of the field is 70 feet wide and 328 feet long; the southern half is the same length but 109 feet wide.

The latter was again subdivided into three equal parts each 111 by 109 feet, or 11,990 square feet. The east end of this field was planted with a mixture of vetch (*Vicia sativa*) and oats (variety Western). The middle division was planted the same day with serradella and the western with Southern cow-pea. Vetch and oats were seeded broadcast, and serradella and Southern cow-pea in drills, three feet three inches apart.

The northern half of Field C was occupied by a series of crops in rows, running north and south, three feet three inches apart, with the exception of the carrots, which were planted in rows fourteen inches apart. The crops were arranged in the following order, beginning at the east end:—

Danvers carrots, ninety rows.

Welcome oats, three rows.

Hairy vetch (*Vicia villosa*), one row.

Small pea (*Lathyrus sativus*), one row.

Sulla (*Hedysarum coronaria*), one row.

Bird's-foot clover (*Lotus corniculatus*), three rows.

*Lotus villosus*, three rows.

Sweet clover (*Melilotus alba*), three rows.

Early cow-pea, one row.

*Euchlœna luxurians*), two rows.

one row.

striped rice, one row.

car cane, seven rows.

ge cane, fifteen rows.

r cane, fifteen rows.

of the plants, with the exception of the carrots, etch and Southern cow-pea, were sent on by the es Department of Agriculture. (For details, ual report, pages 115 to 120.)

1889. — The entire area of both divisions of s carefully prepared in a similar manner as in g spring. It was ploughed and harrowed April tilized broadcast with fine-ground bone and otash, at the rate of six hundred pounds of the wo hundred pounds of the latter. The entire f of the field was planted with roots, while the f was used for raising a variety of fodder and . The majority of the seeds used in this con- sent on by the United States Department of others came from parties more or less directly a the particular variety sent on for trial; some of reliable parties. Most of these seeds were ly for the purpose of studying their particular ptation to our climate and soil, to secure suitable analysis, and to ascertain their relative propor- tial nutritive constituents. As this part of our es exceptional accommodation for analytical to be largely deferred to a more favorable part This circumstance must serve as our excuse g some analyses of the crops raised in 1888 for on the present occasion.

*of the Principal Crops raised on the Southern ion of Field C, beginning at the West End.*

*ruta-baga turnips* of Delano Moore, Presque o rows, 109 feet long and 2 feet apart, were 3. The young plants appeared above ground y were thinned out in the rows to eight inches

of space between them, July 1, and subsequently kept clear from weeds by a periodical use of the cultivator and the hoe. A blight which appeared during the first week of August on the leaves did considerable injury to the earlier foliage; the later leaves suffered less seriously. The crop was harvested October 22; the roots weighed 170 pounds. Photographs representing fair specimens of the roots will be found farther on. An analysis stating the composition of a medium-sized root is reported at the close of this chapter.

*Lane's Sugar Beet.* — The seeds used in this case were sent on by C. H. Lane of Middlebury, Vt. The area occupied by the plant measured 1,090 square feet. The seeds were planted in rows two feet apart, May 3; the young plants appeared above ground May 11; they were thinned out in the rows to six inches space between them June 18, and kept clean from weeds by cultivator and hoe in the same manner as the previously described crop. The first growth of leaves suffered seriously from a blight, the later leaves were entirely free from blight, and made a vigorous growth. The crop was harvested October 19; it weighed 610 pounds, without the leaves. A photograph of different sizes of the roots, and an analysis stating the composition of a medium-sized root, will be found farther on.

*Saxony Sugar Beet.* — This crop occupied an area of 15,587 square feet. The seed was sown in rows two feet apart, to admit the use of a one-horse cultivator, May 3. The seeding was heavy; five and one-half ounces of seed were used. The young plants were thinned out and treated like the previously stated crop. The unfavorable, cold, wet weather during the fore part of the summer season affected this crop in a similar way as the preceding root crops. Insects and a blight destroyed almost entirely the first leaf growth. The later leaves were vigorous, and apparently free from blight. The roots were harvested October 19; they weighed 6,450 pounds, or nine tons per acre, which is about one-half an average crop. Photographs and a chemical analysis accompany these statements.

*Carrots, Danvers.* — The land occupied by this crop measured 18,420 square feet; the seed was sown in rows, leaving fourteen inches of space between, May 13; fourteen

seed were used for that purpose. The plants  
May 21; they were thinned out by hand in the  
two to three inches apart. The crop was kept  
weeding with the hand and the hoe. The leaves  
somewhat from blight during the earlier part of the  
August. The roots were harvested October 17;  
and 11,390 pounds, or 13½ tons per acre.  
The influence of an unfavorable season on the  
root crops has been a marked one. The roots  
smaller than in preceding years; this circum-  
stances with particular force to the different varieties  
sets on trial. The crops have fallen behind in  
more than fifty per cent. of a fair average yield.  
The yield of carrots is one-third less than that obtained in  
previous years.

*of Crops raised on the Northern Division of  
Field C.*

The area of Field C is 70 feet wide and 328 feet long,  
planted in rows from two to three feet apart, as cir-  
cumstances may advise. Most of the crops raised here  
are on trial, to study their general adaptation to our  
climate; a few rows represent in most instances the  
area occupied by each of them. In many  
instances a sufficient amount is raised to secure  
samples for chemical examination. Wherever the  
results in the field and in the laboratory are encouraging,  
other crops new to our section of the country are  
being raised. Larger fields will be devoted subsequently, to  
test the respective agricultural merits on a becoming scale.  
The introduction of reputed forage crops into farm  
practices everywhere, in various directions, promoted  
the progress of agricultural industry. The desirability of  
introducing a greater variety of fodder plants into our farm  
practices is generally conceded. In choosing plants for  
this purpose, it seems advisable to select crops which would  
best supplement our leading fodder crops (aside  
from the products of pastures and meadows),—the fodder  
crops of the Northern Division.

A more detailed discussion of this important question may be found in our fifth annual report, page 88, and sixth annual report, page 115.

The crops were arranged in the following order, beginning at the west end : —

Erfurt earliest cauliflower, two rows.  
 Early snowball cauliflower, two rows.  
 Haines No. 64 tomato, two rows.  
 Honduras sorghum, seven rows.  
 New orange sorghum, seven rows.  
 Kansas orange sorghum, seven rows.  
 Price's new hybrid sorghum, seven rows.  
 Early Tennessee sorghum, seven rows.  
 Bokhara clover (*Melilotus alba*), three rows.  
 Bokhara clover (*Melilotus cæruleus*), three rows.  
*Lotus villosus*, two rows.  
*Pyrethrum roseum*, one row.  
 Sulla (*Hedysarum coronaria*), one row.  
 Pease, one row.  
 Dwarf Lima beans, one-half row.  
 Early cow-pea, one and one-half rows.  
 Black soja bean, five rows.  
 Blue lupine, two rows.  
 Cow-pea, three rows.  
 Horse bean, three rows.  
 Japan clover (*Lespedeza striata*), five rows.  
 Chapman honey plant, three rows.  
 New Japanese buckwheat, seventeen rows.  
 Common barley, fifteen rows.  
 Hulless black barley, fifteen rows.



**American Ruta Baga Turnips.**





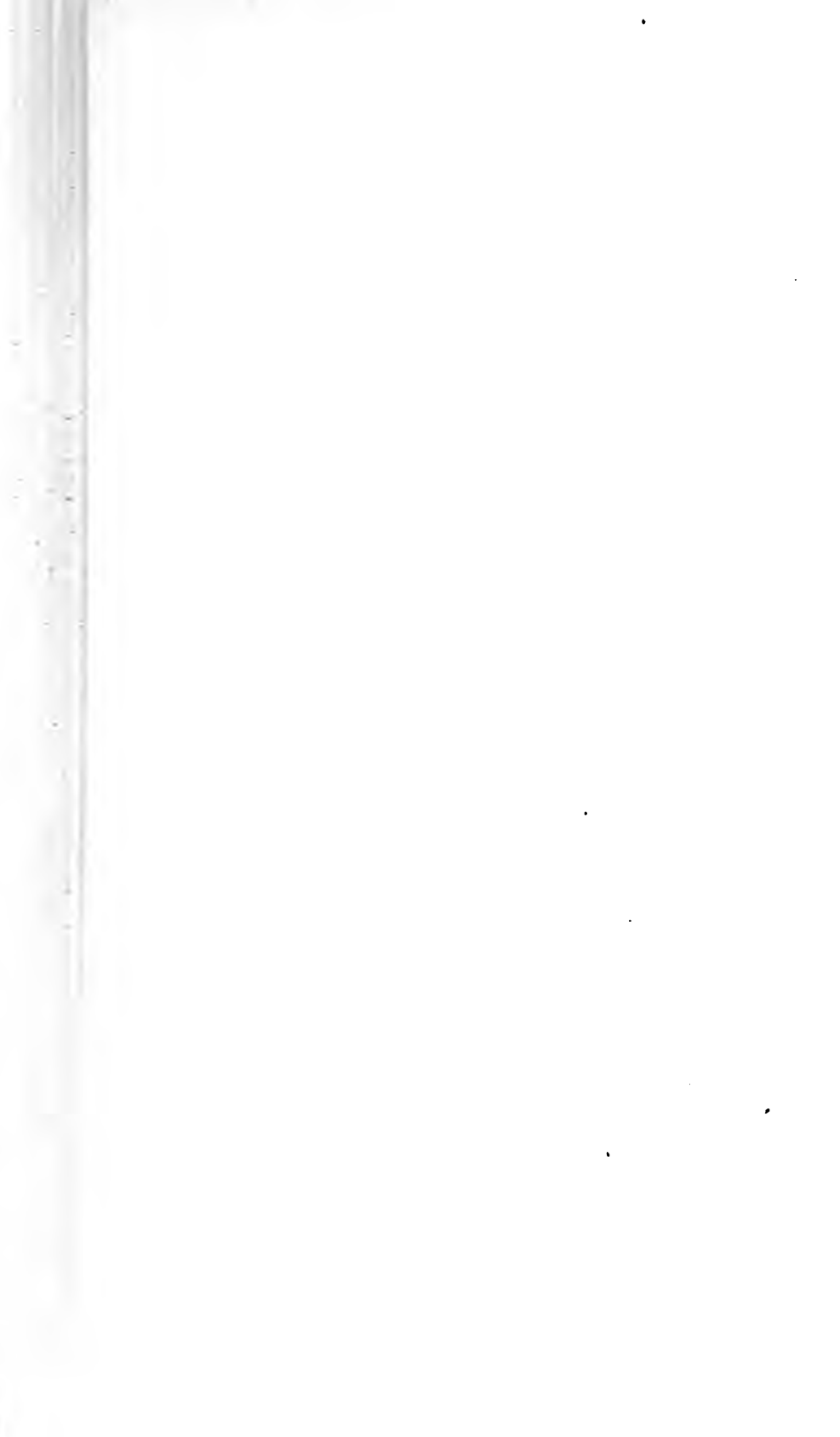


**Saxony Sugar Beets.**

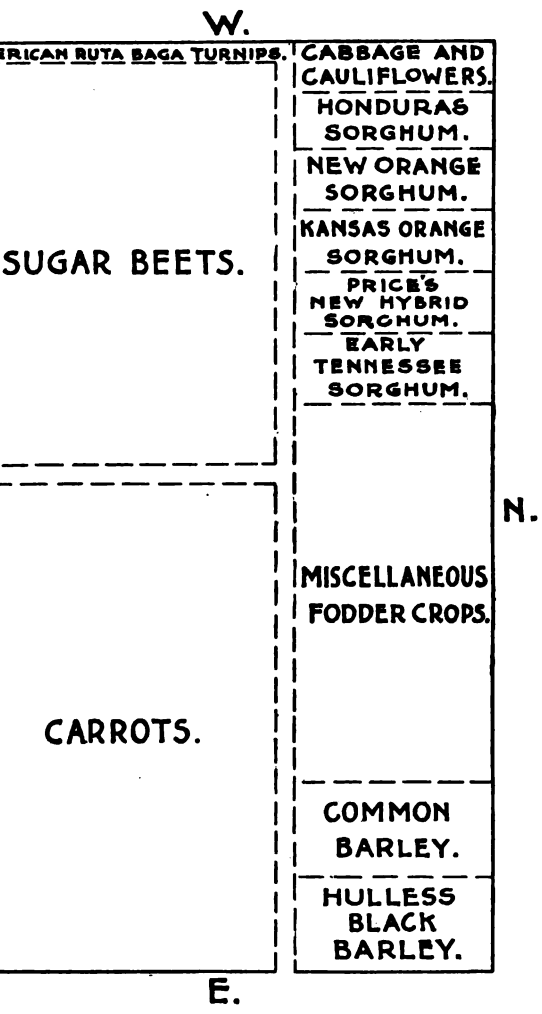


**Lane's Sugar Beets.**





FIELD "C" 1889.



SCALE, 4 RODS TO 1 INCH.

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. *Field D, 1888.* — This field is 328 feet long and 70 feet wide, covering an area of 22,960 square feet. It has been used during previous years for the raising of a variety of garden and field crops, on a larger or smaller scale. The

## FIELD D, 1888.\*

Excelsior Sugar Beet.
Improved Imperial.
Lane's Sugar Beet.
Rus'n Rhubarb.
Potatoes, Plat 1.
Potatoes, Plat 2.
Potatoes, Plat 3.
Garden Vegetables.
Vilmorin Sugar Beet.

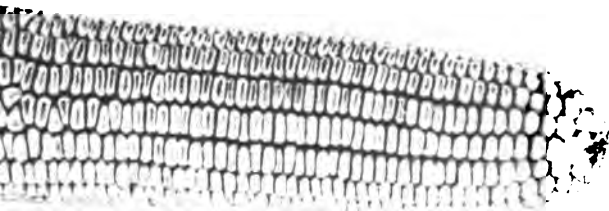
\* Scale, 4 rods to 1 inch.

soil has been usually ploughed late in the fall and early in the succeeding spring. The manure has been applied in every instance early in the spring after ploughing, and subsequently slightly harrowed under. With the exception of the potato plats used for studying the causes of the scab on potatoes, but one fertilizer, consisting of fine-ground bones with muriate of potash, six hundred pounds of the former and two hundred pounds of the latter per acre, has been used upon this field. The distribution of the crops raised during the year 1888 may be seen from the accompanying sketch. Some analyses of crops raised during that year are for stated reasons published farther on for the first time, in connection with analyses made of crops raised during the present year.

1889. — The preparation of the soil as well as the system of manuring, was in all its details the same as in the preceding years. The crops were planted in rows, and kept clean by the timely use of the cultivator and the hoe. They were arranged in the following order, beginning at the west end of the field : —

*Red-cob Ensilage Corn.* — The seed was sent on, with a request for a trial by D. I. Bushnell & Co., St. Louis, Mo. An area of 5,460 square feet was

assigned in this field for our observation. The seed was planted May 7; the young plants appeared above ground in



1. Red Cob Ensilage Corn.



2. Pride of the North Corn.



3. Minnesota King Corn.



4. Clark Corn.



s were first noticed July 30. The growth  
 this time 70 inches in height; it was 105 inches  
 appearance of silk. The field looked extremely  
 handsome at this stage of the growth, — middle

The leaves died, however,  
 beginning at the lower

stalks. Most of the foliage  
 middle of the stalks was dead

ernels began to glaze over.  
 measured 10½ feet in height  
 October 2. The ears were  
 ate not yet fully matured;  
 o to a considerable degree  
 their general development.

475 pounds of ears and  
 of stover.

tionally cool and wet  
 the months of July and  
 o doubt largely contributed  
 satisfactory termination of our  
 matured crop. Late matur-  
 of corn offer but little

us for a successful curing.  
 ensilage has been referred  
 preceding pages (Field B).  
 character of a well-matured  
 handsome corn may be  
 a description and photo-  
 ar sent on to the station,  
 farther on.

(Beauty of Hebron). —  
 for several years assigned  
 o study the causes of scab  
 d and manured in exactly  
 nner as in previous years.  
 anted with healthy tubers,  
 young crop showed itself  
 mly over the entire field,

blight appeared at the close of the month of  
 ead so rapidly that it killed within a week the

FIELD D, 1889.\*

Red-cob Ensilage Corn.
Potatoes, Plat 3.
Potatoes, Plat 2.
Potatoes, Plat 1.
Rus'n Rhubarb.
Minn. King Corn.
Common Oats.
Improved American Oats.
Hargett's White Oats.

\* Scale, 4 rods to 1 inch.

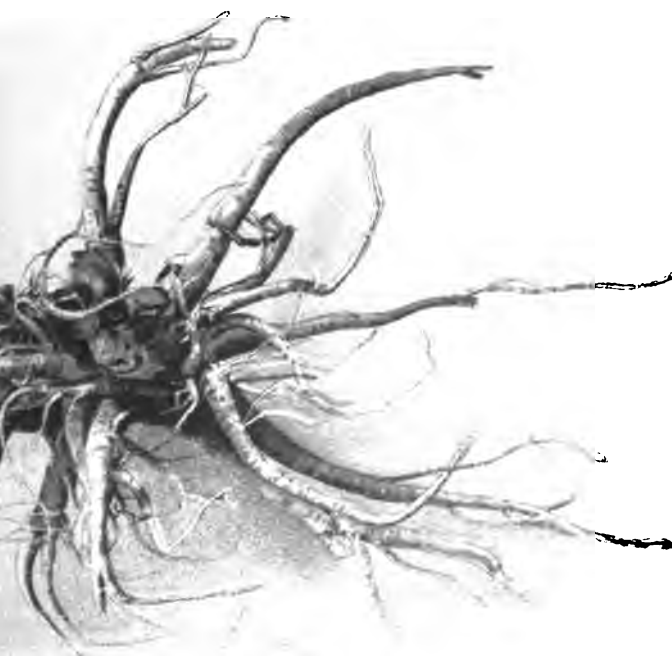


entire vines. The crop was harvested without delay, y proved a total failure; the tubers, almost without an exce tion, were full of scab and soon rotted.

The experiments regarding the cause of scab on potato which for several years past have been carried on upon t part of our field, have been transferred to Field E; th have been placed, since the beginning of 1889, under t special direction of Prof. J. E. Humphrey. His elaborat report regarding his studies of scab and other plant diseas which forms a part of this report, cannot fail to engu the attention of all parties interested in the subject d cussed.

*Minnesota King Corn.* — Two samples were sent on Northrup, Braslan & Goodwin of Minneapolis, Minn. T rows were planted May 14; the plants reached a height 66 inches and matured during the first week of Septemb They compared well with other medium-sized variet current in our vicinity; no special merits were notice The general character of the corn may be judged from short description and photograph which may be fou farther on.

*Oats.* — Three varieties were planted. The seeds of t varieties — “Hargett’s White” (Seizure) and “Improv American” — were sent by the United States Departm of Agriculture; the third variety, commonly called “C necticut Valley Oats,” was secured from a farmer in c vicinity. The latter, one of the most prominent ho varieties of oats, was included in our observation for t purpose of comparing the individual merits, if any, of t different varieties on trial, as far as practicable under c responding circumstances. The seeds were planted, e fifteen rows, two feet apart. The main difference in t advancing growth consisted in a deep-green color of t Improved American. The latter exceeded the other variet by three inches in height at the close of the season. t matured about the same time, and were cut on the same d July 19. When harvested, July 23, the entire crop of t Hargett’s White weighed 360 pounds; of the home varie weighed 350 pounds; of the Improved American, weigh 390 pounds.



Russian Rhubarb Roots.



our grain crops suffered more or less from smut. It was evidently not favorable for comparative trial.

*Rhubarb.*—Some years ago a small sample of this plant was sent on to the station by the American Retail Druggist Association, with a view to experiment with them upon our fields. The sample was presented as genuine by an officer of the Russian Legation who procured it for the association. Several plants from this seed have been for a number of years growing very successfully on our ground. Well-matured plants are collected every year, and some of it was sown in 1900. Quite a number of roots have been collected and sent to druggists. Parties interested in the question of the use of rhubarb for medicinal purposes can secure a specimen of the same readily applied for. An attempt has been made to take a picture of the roots in different positions by the photographs accompanying this chapter. Photographs of this kind of crop have in every instance been taken with care from the camera, that their relative sizes might be preserved.

*of the Ears of Corn illustrated by the Following Photographs.*

*Shenandoah* corn, a dent variety mentioned in this chapter.

*North* corn, a dent variety largely grown upon the Shenandoah grounds.

*King* corn, a dent corn mentioned in this chapter.

*Flint* corn, a flint corn which has served for our observations in 1900 and A.

Number of Rows.	Number of Kernels per Row.	Length of Ear (Inches).	Weight of Ear (Grams).*	Weight of Kernels (Grams).	Weight of Cob (Grams).	Ratio of Cob to Kernels.	Average weight of Kernels (Grams).
16	54	8½	396	339	57	1:5.95	.97
16	46	8	205	178	27	1:6.59	.25
8	44	7½	157	110	47	1:2.34	.31
8	48	8½	159	128	31	1:4.13	.336

\* One ounce equals about thirty grams.

*Teosinte (Euchlaena luxurians).*

[Collected Sept. 7, 1888, in full bloom.]

Moisture at 100° C.,	.	.	.	.	.	.	.	.	.	Per	6
Dry matter,	.	.	.	.	.	.	.	.	.	9	10

*Analysis of Dry Matter.*

Crude ash,	.	.	.	.	.	.	.	.	.	.	2
“ cellulose,	.	.	.	.	.	.	.	.	.	.	5
“ fat,	.	.	.	.	.	.	.	.	.	.	10
“ protein (nitrogenous matter),	.	.	.	.	.	.	.	.	.	.	5
Non-nitrogenous extract matter,	.	.	.	.	.	.	.	.	.	.	10

In green material, moisture 89.42 per cent.; dry matter, 10.58 per cent.

*Fertilizing Constituents of Teosinte.*

Moisture at 100° C.,	.	.	.	.	.	.	.	.	.	6
Calcium oxide,	.	.	.	.	.	.	.	.	.	1
Magnesium oxide,	.	.	.	.	.	.	.	.	.	1
Ferric oxide,	.	.	.	.	.	.	.	.	.	1
Sodium oxide,	.	.	.	.	.	.	.	.	.	1
Potassium oxide (4½ cents per pound),	.	.	.	.	.	.	.	.	.	8
Phosphoric acid (6 cents per pound),	.	.	.	.	.	.	.	.	.	1
Nitrogen (17 cents per pound),	.	.	.	.	.	.	.	.	.	1
Insoluble matter,	.	.	.	.	.	.	.	.	.	1
Valuation per ton,	.	.	.	.	.	.	.	.	.	8

*Lotus villosus (Second Year's Growth).*

[Collected June 21, 1889, in full bloom.]

Moisture at 100° C.,	.	.	.	.	.	.	.	.	.	Per	1
Dry matter,	.	.	.	.	.	.	.	.	.	8	10

*Analysis of Dry Matter.*

Crude ash,	.	.	.	.	.	.	.	.	.	.	2
“ cellulose,	.	.	.	.	.	.	.	.	.	.	1
“ fat,	.	.	.	.	.	.	.	.	.	.	1
“ protein (nitrogenous matter),	.	.	.	.	.	.	.	.	.	.	1
Non-nitrogenous extract matter,	.	.	.	.	.	.	.	.	.	.	1

In green material, moisture 83.37 per cent.; dry matter, 16.63 per cent.

*Lotus villosus* (First Year's Growth).

[Collected Sept. 7, 1888, blooming.]

	Per Cent.
C., . . . . .	12.36
. . . . .	87.64
	<hr/> 100.00

*Analysis of Dry Matter.*

. . . . .	8.30
. . . . .	15.07
. . . . .	2.69
nitrogenous matter), . . . . .	16.12
extract matter, . . . . .	57.82
	<hr/> 100.00

Material, moisture 88.63 per cent. ; dry matter, 11.37 per cent.

*Fertilizing Constituents of Lotus villosus.*

C., . . . . .	12.360
. . . . .	2.861
H., . . . . .	.615
. . . . .	.148
. . . . .	.633
(4½ cents per pound), . . . . .	1.550
(6 cents per pound), . . . . .	.500
(8 cents per pound), . . . . .	2.259
. . . . .	1.053
n, . . . . .	\$9 60

*Sulla* (*Hedysarum coronaria*).

[Collected Oct. 3, 1888, at the close of the period of blooming.]

	Per Cent.
C., . . . . .	10.46
. . . . .	89.54
	<hr/> 100.00

*Analysis of Dry Matter.*

. . . . .	8.77
. . . . .	12.38
. . . . .	3.16
nitrogenous matter), . . . . .	17.03
extract matter, . . . . .	58.66
	<hr/> 100.00

Material, moisture 74.21 per cent. ; dry matter, 25.79 per cent.

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*Fertilizing Constituents of Sulla.*

	Per
Moisture at 100° C., . . . . .	10.
Calcium oxide, . . . . .	2.
Magnesium oxide, . . . . .	.
Ferric oxide, . . . . .	.
Sodium oxide, . . . . .	.
Potassium oxide (4½ cents per pound), . . . . .	1.
Phosphoric acid (6 cents per pound), . . . . .	.
Nitrogen (17 cents per pound), . . . . .	2.
Insoluble matter, . . . . .	.
Valuation per ton, . . . . .	\$10.

*Hairy Vetch (Vicia villosa).*

[Collected Sept. 3, 1888, blooming]

	Per
Moisture at 100° C., . . . . .	9.
Dry matter, . . . . .	10.

*Analysis of Dry Matter.*

Crude ash, . . . . .	.
“ cellulose, . . . . .	3.
“ fat, . . . . .	.
“ protein (nitrogenous matter), . . . . .	1.
Non-nitrogenous extract matter, . . . . .	3.
	10.

In green material, moisture 78.01 per cent ; dry matter, 21.99 per cent.

*Bokhara or Sweet Clover (Melilotus alba).*

[Collected Oct. 3, 1888, at the close of the period of blooming.]

	Per
Moisture at 100° C., . . . . .	9.
Dry matter, . . . . .	10.

*Analysis of Dry Matter.*

Crude ash, . . . . .	.
“ cellulose, . . . . .	2.
“ fat, . . . . .	.
“ protein (nitrogenous matter), . . . . .	1.
Non-nitrogenous extract matter, . . . . .	5.
	10.

In green material, moisture 76.52 per cent. ; dry matter, 23.48 per cent.

*Fertilizing Constituents of Bokhara Clover.*

	Per Cent.
° C., . . . . .	6.360
ide, . . . . .	1.938
. . . . .	.373
. . . . .	.028
. . . . .	.077
e (4½ cents per pound), . . . . .	1.673
d (6 cents per pound), . . . . .	.436
ents per pound), . . . . .	1.770
er, . . . . .	.013
on, . . . . .	\$7 96

*Melilotus cœruleus.*

Collected Aug. 6, 1889, somewhat past blooming.]

	Per Cent.
° C., . . . . .	8.22
. . . . .	91.78
	<hr/> 100.00

*Analysis of Dry Matter.*

. . . . .	14.87
e, . . . . .	27.17
. . . . .	1.67
(nitrogenous matter), . . . . .	13.07
as extract matter, . . . . .	43.22
	<hr/> 100 00

*Fertilizing Constituents of Melilotus cœruleus.*

° C., . . . . .	8.220
. . . . .	1.449
ide, . . . . .	.260
. . . . .	.349
. . . . .	.270
e (4½ cents per pound), . . . . .	2.796
d (6 cents per pound), . . . . .	.544
ents per pound), . . . . .	1.919
er, . . . . .	4.008
on, . . . . .	\$9 55

*Danvers Carrots.*

[Grown on Field C, 1888.]

	Per Cent.
° C., . . . . .	90.05
. . . . .	9.95
	<hr/> 100.00

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*Analysis of Dry Matter.*

	Per Cent
Crude ash, . . . . .	8.2
“ cellulose, . . . . .	10.2
“ fat, . . . . .	1.6
“ protein (nitrogenous matter), . . . . .	7.9
Non-nitrogenous extract matter, . . . . .	71.8

100.0

Nutritive ratio, 1 : 9.17.

*Carrot Tops (Danvers).*

[Collected Oct. 31, 1889, two weeks after harvesting.]

	Per Cent
Moisture at 100° C., . . . . .	9.7
Dry matter, . . . . .	90.2

100.0

*Analysis of Dry Matter.*

Crude ash, . . . . .	13.8
“ cellulose, . . . . .	13.6
“ fat, . . . . .	2.0
“ protein (nitrogenous matter), . . . . .	20.1
Non-nitrogenous extract matter, . . . . .	50.3

100.0

In green material, moisture, 76.79 per cent. ; dry matter, 23.21 per cent.

*Sugar Tests of Sorghum (1889).*

[Per Cent.]

	Moisture at 100° C.	Glucose.	Sucrose.	Total Sugar.
Early Tennessee (over-ripe), . . . . .	77.43	1.79	3.21	5.00
Price's New Hybrid (ripe), . . . . .	77.80	2.92	3.78	6.70
Kansas Orange (green), . . . . .	80.67	2.38	3.63	6.01
New Orange (green), . . . . .	78.30	2.96	3.85	6.81
Honduras (green), . . . . .	77.55	3.08	4.01	7.09

*Beets, Field D (1888).*

ar Beet; II. Improved Imperial; (?) III. Vilmorin Sugar Beet.]

	PER CENT.		
	I.	II.	III.
° C., . . . . .	86.95	90.60	86.73
. . . . .	13.05	9.40	13.27
	100.00	100.00	100.00
s of Dry Matter.			
. . . . .	3.21	10.09	5.70
e, . . . . .	5.83	7.83	4.82
. . . . .	.72	1.80	.73
(nitrogenous matter),	8.74	12.78	8.45
us extract matter, .	81.50	67.50	80.30
	100.00	100.00	100.00
. . . . .	9.84	3.45	7.24

*Fertilizing Constituents of the Above Beets.*

	PER CENT.	
	II.	III.
° C., . . . . .	90.600	86.730
. . . . .	.045	.056
ide, . . . . .	.030	.037
. . . . .	.005	.009
. . . . .	.104	.170
e, . . . . .	.462	.170
d, . . . . .	.086	.028
. . . . .	.192	.181
er, . . . . .	.015	.090
on, . . . . .	\$1 14	\$0 79

*Beets, Field D (1888).*

[IV. Lane's Sugar Beet; V. New Market Gardener Beet; VI. Eclipse Beet;  
VII. Osborn's Selected Beet.]

	PER CENT.			
	IV.	V.	VI.	VII.
Moisture at 100° C., . . . .	84.56	89.65	90.25	88.80
Dry matter, . . . .	15.44	10.33	9.75	11.20
	100.00	100.00	100.00	100.00
<i>Analysis of Dry Matter.</i>				
Crude ash, . . . .	6.87	7.21	9.77	7.80
“ cellulose, . . . .	6.17	7.56	7.22	6.70
“ fat, . . . .	.66	.59	.74	.60
“ protein (nitrogenous matter), . . . .	10.63	14.29	15.40	14.40
Non-nitrogenous extract matter, . . . .	75.67	70.35	66.87	70.30
	100.00	100.00	100.00	100.00

*Fertilizing Constituents of the Above Beets.*

	PER CENT.		
	V.	VI.	VII.
Moisture at 100° C., . . . .	89.650	90.250	88.800
Calcium oxide, . . . .	.032	.044	.064
Magnesium oxide, . . . .	.022	.032	.028
Ferric oxide, . . . .	.003	.005	.002
Sodium oxide, . . . .	.060	.110	.156
Potassium oxide, . . . .	.481	.467	.313
Phosphoric acid, . . . .	.085	.091	.069
Nitrogen, . . . .	.236	.240	.259
Insoluble matter, . . . .	.009	.016	.010
Valuation per ton, . . . .	\$1 41	\$1 33	\$1 23

*etermination of Albuminoid Nitrogen (1888).*

	PER CENT. IN DRY MATTER.		
	Albuminoid Nitrogen.	Non-albuminoid Nitrogen.	Total Nitrogen.
. . . . .	.58	.82	1.40
. . . . .	.85	1.19	2.04
. . . . .	.50	.85	1.35
. . . . .	.67	1.03	1.70
. . . . .	.76	1.53	2.29
. . . . .	.84	1.63	2.47
. . . . .	.78	1.53	2.31

*Potatoes (1887).*

by tubers; II. Beauty of Hebron, healthy tubers; III. Beauty of healthy tubers; IV. Beauty of Hebron, scabby tubers.]

	PER CENT.			
	I.	II.	III.	IV.
ure, . . . . .	80.20	80.73	81.53	82.15
matter, . . . . .	19.80	19.27	18.47	17.85
	100.00	100.00	100.00	100.00
<i>of Dry Matter.</i>				
. . . . .	5.17	5.17	6.27	6.35
e, . . . . .	1.91	3.32	3.22	3.55
. . . . .	0.62	0.57	0.52	0.58
(nitrogenous matter),	10.74	9.58	9.73	10.70
us extract matter, .	81.56	81.36	80.26	78.80
	100.00	100.00	100.00	100.00
rogen, in dry matter,	.91	.73	.77	.92
d nitrogen, in dry	.80	.80	.79	.79
ogen, in dry matter, .	1.71	1.53	1.56	1.71

*Tabular Statement, showing the Loss in Weight, by Evaporation  
Moisture, of Two Potatoes (Beauty of Hebron) kept in a  
Cellar.*

[Weight of potatoes Sept. 13, 1887: No. 1, 103.1210 grams; No. 2, 90.5225 grams.]

DATE OF WEIGHING.	PER CENT. OF ORIGINAL WEIGHT LOST SINCE PRECEDING WEIGHING.		PER CENT. OF ORIGINAL WEIGHT LOST SINCE SEPT. 13, 1887.	
	Potato No. 1.	Potato No. 2.	Potato No. 1.	Potato No. 2.
<b>1887.</b>				
September 26, . . .	1.43	1.43	1.43	1.43
October 10, . . .	.74	.72	2.17	2.15
October 24, . . .	.67	.66	2.84	2.81
November 7, . . .	.55	.53	3.39	3.32
November 21, . . .	.50	.48	3.89	3.80
December 5, . . .	.52	.51	4.41	4.31
December 19, . . .	.55	.52	4.96	4.83
<b>1888.</b>				
January 2, . . .	.55	.53	5.51	5.36
January 16, . . .	.66	.68	6.17	6.04
January 30, . . .	.66	.70	6.83	6.74
February 13, . . .	.89	.93	7.72	7.67
February 27, . . .	1.47	1.41	9.19	9.08
March 12, . . .	1.71	1.78	10.90	10.86
March 28, . . .	2.23	2.20	13.13	13.06
April 9, . . .	2.01	1.88	15.14	14.94

Both potatoes began to sprout Jan. 7, 1888.

*American Ruta-baga Turnips (1889).*

	Per Cent.
0° C., . . . . .	91.75
. . . . .	8.25
	<hr/> 100.00
<i>Analysis of Dry Matter.</i>	
. . . . .	11.89
e, . . . . .	13.12
. . . . .	1.26
(nitrogenous matter), . . . . .	11.46
us extract matter, . . . . .	62.27
	<hr/> 100.00

*Fertilizing Constituents of American Ruta-baga Turnips.*

0° C., . . . . .	91.750
. . . . .	.083
ide, . . . . .	.030
. . . . .	.005
. . . . .	.009
le, . . . . .	.468
d, . . . . .	.106
. . . . .	.151
er, . . . . .	.015
ton, . . . . .	\$1 04

*Lane's Sugar Beet (Field C, 1889).*

	Per Cent.
0° C., . . . . .	90.13
. . . . .	9.87
	<hr/> 100.00
<i>Analysis of Dry Matter.</i>	
. . . . .	14.54
e, . . . . .	9.69
. . . . .	.83
(nitrogenous matter), . . . . .	13.01
us extract matter, . . . . .	61.93
	<hr/> 100.00

*Fertilizing Constituents of Lane's Sugar Beet.*

0° C., . . . . .	90.130
. . . . .	.062
ide, . . . . .	.043
. . . . .	.007
. . . . .	.006
le, . . . . .	.720
d, . . . . .	.134
. . . . .	.205
er, . . . . .	.038
ton, . . . . .	\$1 47

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*Saxony Sugar Beet (Field C, 1889).*

EXPERIMENTS WITH GREEN CROPS FOR SUMMER  
FEED OF MILCH COWS. (FIELD F.)

selected for the raising of green fodder crops  
with milch cows (see second feeding ex-  
periment 48 of this report), had been used for a  
number of years as a meadow for the production of hay.  
In the fall of 1887, a piece of land, 300 feet long and  
100 feet wide, was ploughed, and the succeeding spring,  
when in a proper mechanical condition was secured,  
sown with Hungarian grass. After this crop was  
harvested and put into a silo, the soil was turned, and left in that  
condition the following year.

In working out our plans for future experiments  
conducted in the field, it was decided to turn the still existing  
available plant food to account for the raising  
of cow-peas, serradella, and a mixture of vetch.  
This decision was made for the following rea-  
sons: The green crops had given much satisfaction in preceding  
years when fed as green fodder to milch cows; they  
yielded more from our own experience in adjoining  
fields than the yield when following grass and corn without  
manure; and they would each reach in a desired  
stage of growth best adapted for their profit-  
able use as green fodder. The field was ploughed and  
sown early in the season (April, 1889), and subse-  
quently divided into three equal parts, 300 feet long  
and 100 feet wide, with four feet unoccupied space between  
the rows (see sketch, Field F).

Along the north side of the field, 12,900 square  
feet were sown broadcast with twenty-five pounds each of  
cow-peas, April 26.

The subdivision was sown in drills three feet apart,  
with twenty-five pounds of serradella seed. May 8.

Along the south side of the field was sown in  
drills three feet apart, with twenty-five pounds of Southern  
hay variety), April 8.

*Oats.*—The oats appeared first above ground;  
they were followed, May 6. The crop was eleven inches

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high, June 11; it measured twenty-five inches, June 19. The oats began to head out, June 24, and the vetch to bloom, June 25; the entire growth was, on an average, thirty inches high, June 28, when the cutting for the daily feed began. The last of the crop was cut July 17; it had reached a height of forty inches. The average moisture of the green fodder for the entire period was 78.26 per cent., which makes the solid vegetable matter 21.74 per cent. The entire yield of the green crop was 5,440 pounds, or  $8\frac{1}{2}$  tons per acre. This result is not as good, as far as quantity is concerned, as that secured during the preceding year, when a mixture of 25 pounds of vetch and 50 pounds of oats were used as seed; the rate of yield per acre in that year was  $9\frac{1}{2}$  tons of green fodder. The area occupied by vetch and oats was not large enough to answer fully our purpose, to cover the time until the cow-pea is fit to be used advantageously. We shall hereafter double the area and seed one-half down, as we did before, towards the close of April, and the other half from two to three weeks later.

*Serradella*.—The young plants were out May 16. The crop was kept clean with the cultivator and hoe. It is a peculiar feature of this crop, that its growth is very slow until it begins to bloom, when it rapidly branches out, and causes finally a compact, bulky green mass, filling out completely the three feet of space between the rows. The seed was sown, May 8; the plants appeared above ground, May 16; they were but one inch high, June 11; two inches, June 19; two and one-half inches, June 26; and four inches, July 3; began blooming, July 6; ten inches high, July 24; began spreading, July 31; reached thirteen inches in height, August 21. The first feed was cut September 11, when it formed a dense mass, several feet wide; the last feed was cut September 27. The green crop harvested amounted to 8,350 pounds, or  $13\frac{1}{2}$  tons per acre. The average moisture was 83.6 per cent., and the solid vegetable matter 16.35 per cent.

*Southern Cow-pea*.—The young plants were seen six days after planting. The crop was cultivated and kept

mon with the preceding one; its leaves were  
ed by frost, May 29. The growth was three  
June 11; five and one-half inches, June 26;  
July 3; seventeen inches, July 17; twenty-four  
st 21, when blossoms appeared. The first cut  
as made September 1, and the last, September  
ire yield of green fodder amounted to 6,125  
0 tons per acre. The average moisture of the  
d was 83.07 per cent., leaving, for the solid  
tter, 16.93 per cent. The frequent rains during  
ner and the autumn have apparently favored an  
e yield of green fodder. Whether their com-  
suffered, will be learned from a comparison of  
of past years.

l characteristics of the crops above mentioned  
ted in previous reports, and their good services  
are confirmed by our own observations. We  
eat in this connection the views advanced in  
rts.

se of raising a greater variety of valuable crops  
der deserves the serious consideration of farmers  
e dairy business; for it secures a liberal supply  
utritious fodder, at the same time when hay  
ce and costly, and when it would be still a  
ctice to feed an imperfectly matured green

The frequently limited area of land fit for a  
production of grasses, and the not less recog-  
ted condition of a large proportion of natural  
ke it but judicious to consider seriously the  
promise not only to increase, but also to  
products of the dairy.

er ought to make his selection, from among the  
er plants, to suit his individual resources and  
adopting this basis as his guide, he ought to  
ction on the basis that the crop which is capable  
, for the same area, the largest quantity of  
aining food constituents, at the least cost, is, as  
ost valuable one for him.

ment fodder crops may be classified, in regard  
e proportion of their nitrogenous organic food

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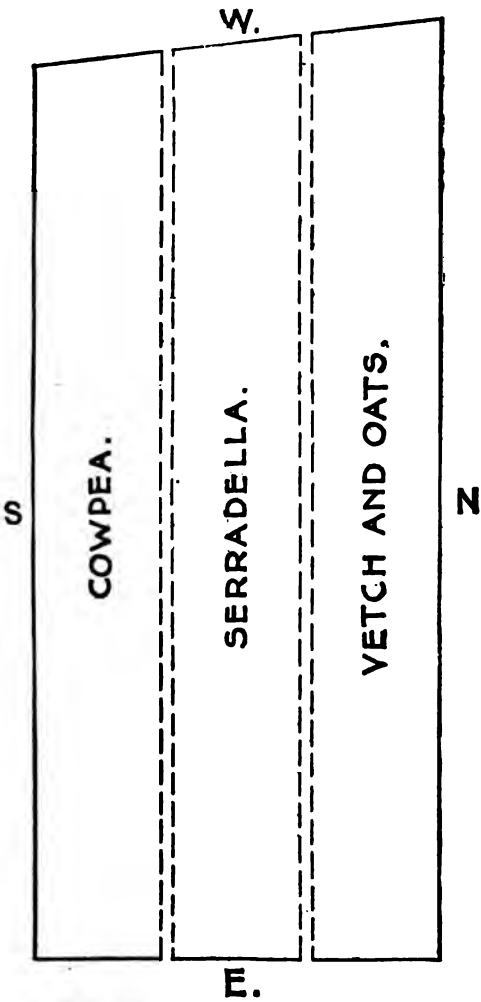
constituents to their non-nitrogenous organic food constituents (nutritive ratio), in the following order : —

1. Leguminous plants, clovers, vetches, etc., . . . 1 : 2.2 to 1 :
2. Grasses, . . . . . 1 : 5.0 to 1 :
3. Green corn, roots and tubers, . . . . . 1 : 6.0 to 1 :

A liberal introduction of reputed forage crops into farm operations has everywhere, in various directions, promoted the success of agricultural industry. The desirability of introducing a greater variety of fodder plants into our farm management is generally conceded. In choosing plants for that purpose, it seems advisable to select crops which would advantageously supplement our leading fodder crop (as corn from the products of pastures and meadows), — the fodder corn and corn stover.

Taking this view of the question, the great and valuable family of leguminous plants, as clovers, vetches, lucerne, serradella, pease, beans, lupines, etc., is, in a particular degree, well qualified for that purpose. They deserve a decided recommendation in the interest of a wider range for the economical systems of rotations, under various conditions of soil and different requirements of markets. Most of these fodder plants have an extensive root system, and for this reason largely draw their plant food from the lower portion of the soil. The amount of stubble and roots they leave behind after the crop has been harvested is exceptionally large, and decidedly improves both the physical and chemical condition of the soil. The lands are consequently better fitted for the production of shallow-growing crops as grains, etc. Large productions of fodder crops assist in the economical raising of general farm crops. Although the area devoted to cultivation is reduced, the total yield of the land is usually more satisfactory.

FIELD "F" 1889.



SCALE, 4 RODS TO 1 INCH.

## V. NOTES ON MISCELLANEOUS FIELD WORK.

Although the entire farm land of the station has been placed under a careful supervision, as far as records of manuring, modes of cultivation and proper selection of crops for cultivation are concerned, a considerable part of it is now yet engaged in a strictly experimental work. The course adopted in the management of some fields aims at a time preparation for some definite experiment contemplated in the near future; in others, to fit them for an economical production of fodder crops for the support of farm live stock. The fields designed for the cultivation of fruit bearing trees and shrubs, to study the causes and the character of the diseases they are frequently heir to, are subdivided, and each plat subjected to a systematic treatment with different kinds and forms of manurial substances. The outlines of the area selected for permanent meadows are better defined, and the condition of the lands improved by underdraining and ditching; different portions of the meadows are stocked with different varieties of grasses, to test their adaptation and their economical value. The ploughed lands are subjected periodically, whenever practicable, to drill cultivation, in the interest of a clean culture.

As the work accomplished in this direction can be better appreciated when stated later on in connection with the different results secured, a mere enumeration of the principal field crops raised during the past season may suffice here.

Hay, . . . . .	37 tons.
Rowen, . . . . .	15 tons.
Corn for ensilage, . . . . .	19 tons.
Carrots, . . . . .	5½ tons.
Sugar-beets, . . . . .	4 tons.
Barley, grain and straw, . . . . .	5,750 pounds.
Oats, grain and straw, . . . . .	5,350 pounds.
Corn on the cob, . . . . .	5,250 pounds.
Fodder corn, . . . . .	7,000 pounds.
Corn stover, . . . . .	7,000 pounds.
Sorghum fodder, . . . . .	2,000 pounds.
Vetch and oats (green), . . . . .	5,450 pounds.
Cow-pease (green), . . . . .	6,600 pounds.
Serradella (green), . . . . .	8,350 pounds.

## DEPARTMENT OF VEGETABLE PHYSIOLOGY.

REPORT BY PROF. JAMES ELLIS HUMPHREY.

Year of my work in this department has been of organization and equipment. Beginning in a moment and in limited quarters, no elaborate arrangement was possible. The liberality of the last Legislature removed this difficulty, however, and the new green-house provided for the department are now completed and occupied. Views of the new accommodation are given with this report.

Arrangement for certain lines of work, especially for the study of various diseases of plants, is now fairly good, and preliminary sections are well begun.

The year for 1889 comprises the following divisions:—

1. General account of the *Fungi*, with special reference to the various diseases of cultivated plants.

2. Studies on the potato scab, carried on during the

3. Studies on various diseases of plants, which have been more numerous at the station farm the past season.

4. Examination of specimens from other sources, referred to the department for examination and report.

#### 1. General Account of the *Fungi*.

A few years have been marked, in the United States, by a rapidly increasing interest in the relations of fungi to the plants which they attack, and by a growing knowledge of the dreaded *rusts*, *smuts*, *mildews*, *blights* and other diseases, and of their economic importance. Diseases, once regarded as mysterious, unavoidable, and "visitations," are coming to be generally understood to be simple, direct effects of natural causes, open to study and amenable to treatment. As our understanding comes, naturally, a comprehension of the practical utility of the scientific investigation of these diseases in all their phases.

Information on *fungi* for popular information, meets at the present time a want not experienced by all scientific writers,

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in the very nature of the *fungi* themselves. It is not easy to comprehend that organisms so small and so inconspicuous can possess such power for harm; and it is not easy for a layman to understand that, in spite of their minuteness, they pass through life-cycles as constant and as definite as those of the plants on which they grow. It seems, therefore, worth while to attempt a general sketch of the growth and classification of those organisms of a vegetable nature which attack and cause diseases of plants cultivated for useful products or for ornament. This account may serve as an introduction to the present as well as to future publications of this station on the subject of plant diseases, and to familiarize the reader, once for all, with the use of certain technical terms which are essential to exactness of statement. For the use of such terms no apology is needed. Their seeming difficulty lies simply in their unfamiliarity, which, as with all new words, soon wears away through use; while their advantage over words already familiar is that they convey precise ideas, unmodified by preconceptions, and so greatly aid in clearness and definiteness of thought. The words printed in SMALL CAPITALS in the following pages may serve, also, as a general reference list of technical or semi-technical terms, whose use is essential in treating of plant diseases, and whose meanings are here explained, will be assumed for the future to be understood by the readers of the publications of this station.

Any plant consists of one or more of the elementary plant-units, known as CELLS. A cell consists essentially of a mass of the semi-fluid living substance which is the basis of all life, usually surrounded by a firm membrane, known as the CELL-WALL. The simplest plants consist of a single cell each; but the higher plants, on the other hand, are made up of immense numbers of cells, intimately united. Every living plant requires, for the renewal of worn parts and the growth of new parts, a supply of the materials necessary to such renewal and growth. Since both the living matter and the wall of the cell consist of compounds of a highly complex chemical constitution, the plant must be furnished with substances which contain the necessary chemical elements, in such form as to be readily converted

vegetable tissue. Such substances constitute the food of plants, in the same sense that what an animal eats is its food; and both plants and animals find their food-supply only in *organic* substances. Inorganic substances can no more serve plants than they can serve animals; and just here a distinction must be made between the true food of plants and "plant food," so called in connection with the use of fertilizers. We shall see later what is the difference between the food of the plant and the food of the animal, which consists of inorganic substances.

We know that an animal must obtain its food in a ready formed; that is, it cannot prepare the food for itself; it requires it from inorganic substances, but it obtains it from plants or from other animals. Here lies the great distinction between animals and *green* plants; and of the fact that, to most persons, the word *plant* connotes the idea of greenness, it is by no means true that all plants are green. Green plants owe their color to the presence in their leaves and other green parts of a special substance known as leaf-green or CHLOROPHYLL. It may be that some plants which are not green to the eye, yet contain chlorophyll, whose presence is hidden by some other pigment. The term "green plants" is here used, to designate all *chlorophyll-containing* plants, whatever their external appearance.

Chlorophyll we have the remarkable substance which bridges the gap between the inorganic and the organic. It is a substance in nature on whose activity the continuity of life depends. It alone has the power of forming organic materials out of the elements of inorganic substances, but only under certain definite conditions. The roots of land plants receive water from the soil by osmosis through the roots and stems, and absorb from the atmosphere carbonic acid gas, or *carbon-dioxide*, which it takes in in small proportion. These two simple inorganic substances, water and carbon-dioxide, furnish the elements, *hydrogen* and *oxygen*, for the formation of certain organic compounds; and it is the peculiar property of chlorophyll that, in its presence, and in its presence *only*, these elements are freed from their original combinations,

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and recombined into such organic compounds ; though the changes can take place only when the chlorophyll is exposed to light of sufficient intensity, and when the water is supplied to it holds in solution suitable inorganic compounds containing *nitrogen, potassium, phosphorus, calcium, magnesium, iron and sulphur*. Under natural conditions, water from any soil in which plants will grow will be found to contain all these substances ; but, in consequence of repeated cultivation and removal of the crops, the supply of these materials in a soil becomes greatly reduced, or, as we say, the soil becomes "exhausted." It then becomes necessary to supply the lacking constituents to the soil in the form of manures or fertilizers ; and it is these necessary elements which are commonly spoken of as "plant food." Being inorganic, they cannot serve as food to the plant ; but, as we have seen, their presence is indispensable to the elaboration of the true food of the plant from the materials furnished by water and carbon-dioxide. The precise relation of most of these elements to the life of the plant is hardly at all understood ; but it is easy to show that, in the absence of either of them, there can be no permanently healthy activity. Their relation to the elaboration of organic food material from inorganic compounds has been compared, perhaps aptly, to that of oil to the smooth running of a steam-engine.

The necessary conditions being fulfilled, then, there occurs a recombination of the constituents of water and carbon-dioxide into organic substance, excepting a part of the *oxygen*, which is set free into the atmosphere. Whether ever temporary combinations they may pass through, the first visible and stable form in which these recombined elements appear is usually that of *starch*, which is the commonest form of organic food material that occurs in plants. After it is thus provided, by the activity of its chlorophyll, with an organized food supply, the plant utilizes it, as it needs, for the formation of tissue, either in repairing worn or in new growth.

But not all plants contain chlorophyll. Very many resemble animals in being entirely unable to provide their own nourishment, and in being, therefore, wholly dependent on external sources of food supply. Since their food supply

organic substances, it is evident that it must come from two sources; either from living organisms, vegetable, or from dead organisms in a more or less advanced state of decomposition. Among flowering plants there are a few which are thus dependent, the best known are the white "Indian pipe" (*Monotropa*), and the "Dodder," which twines its yellow-colored leafless stems about our golden-rods and similar plants. But nearly all of the chlorophyll-less plants have a simpler structure. They are mostly very simple, showing no distinction of separate organs, like the leaves of higher plants.

Parasitic plants may best be grouped under three classes: the *Fungi*, the *Bacteria*, and the *Slime Moulds*. Those which live on decaying organic matter, the remains of dead organisms of various sorts, and are known as SAPROPHYTES or corpse-plants. Others, on the contrary, resemble parasites in drawing their nourishment directly from living organisms, on which they are said to be PARASITES. The animal at whose expense the parasite lives is its host. It is this latter class of plants which has attracted the most interest to all who cultivate the higher plants, since they cause the numerous and frequent plant diseases known as *fungous* diseases. As we have seen, they draw their food from their host plants for the purpose of obtaining the food supply necessary to their growth, which is often obtained, from lack of chlorophyll, to provide for

The effects of different parasites on their host plants vary greatly. It is evident that the host plant must always be injured by being robbed of a part of its food; but the injury is often seems, in some cases, to be insignificant, so that no serious damage results. On the other hand, the injury to the host is sometimes so rapid and so complete that there can be no doubt that the parasite exercises a more severely fatal influence than merely that of turning away the supply of the plant from its proper channels. Between these extremes one may observe all degrees of injury on the part of the various parasites; and the injury caused by any particular one may vary widely in

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different cases, being largely controlled by varying conditions.

The great majority of parasitic fungi develop and vegetate within the tissues of their hosts; but some forms live and grow superficially, merely sending small branches into the cells of their hosts, for the purpose of absorbing nourishment. These *external* parasites are, as a rule, much less injurious to the plants they attack than are *internal* parasites.

A striking influence is often exerted on the habit of growth of a plant by the attacks of a parasite. Thus, it is often possible to tell which among a number of plants are infected, by their appearing taller or shorter, or slenderer or stouter, than the healthy plants; or they may appear of a lighter or darker shade of color; or, as frequently happens, the development of a fungus in the tissues of a plant may cause the affected parts to become abnormally developed and distorted to such an extent as to attract the attention of even the casual observer.

Just here should be noted an important fact for the student of parasitic fungi. As a rule, a given parasite is adapted to live on only a single host species, or on a few closely related species, seeming to require for its development the special chemical and other conditions afforded by some particular plant or particular group of similar plants. But on the other hand, closely related parasites may attack widely different plants. For example, there is a very common "rust" which attacks the Canada thistle, and another which is equally common on grasses and grains. The two rusts are very closely related, while the relationship between the thistles and the grasses is very remote. Neither of the rusts can live on the host plant of the other.

The distinction between parasites and saprophytes, while very useful, must not be made too strict; for there are numerous fungi which, while naturally saprophytes, occasionally assume the role of parasites under certain conditions, and others which may live as saprophytes, for a time at least, though ordinarily obtaining their nourishment parasitically. Many fungi, also, are probably parasites in some and saprophytes in other parts of the life-cycle.

pass now to a more particular account of the  
corophyll-less plants already mentioned.

MOULDS comprise a comparatively small num-  
most of which are strictly saprophytic in their

A few of the simpler ones, however, are  
and their life history may be briefly sketched.

The winter or other unfavorable period in a so-  
g state, in which condition they appear as tiny

es, each consisting of a mass of living matter,  
y a tough, firm coat. When warmth and moist-

these outer coats crack open, and the living  
e and begin to actively creep about, seeking for

n which they are able to live. Failing in this  
of these tiny creeping masses soon dies; but,

it penetrates the cells of the host plant, and  
grow and mature at its expense. Toward the

rowing season, the masses of living substance,  
greatly increased in size and now occupy the

cells of the host whose contents they have  
eak up into many very small portions, each of

the resting state by becoming surrounded with  
, and so awaits the next season. These organ-

ly of the simplest nature, and it would perhaps  
call them simply *organisms*, than to try to

a place on either side of the shadowy and  
e which separates the lowest plants and ani-

early universal consent, however, their study  
o the botanists. The most important member

o, economically, is perhaps the parasite which  
club-foot" of cabbages and turnips, incidentally

the article on "Potato Scab," in the report of  
or 1888.

ERIA, or "germs," include the smallest known  
with both saprophytic and parasitic forms, and

y which can live in either way. They consist  
heres, rods and threads, whose vital activity is

many most remarkable phenomena. Among  
live saprophytically, one form produces the

of dead organic matter; another causes the  
ilk; another, the change of alcohol into acetic

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acid, which occurs when cider is converted into vinegar; another produces the rancidity of butter; and so on, through a long list. Many of the parasitic bacteria live in the bodies of men or other animals, and produce the most dreaded and dreadful contagious or *zymotic* diseases, like small-pox, anthrax or splenic fever, diphtheria, Asiatic cholera, bubonic cholera, Southern cattle fever, chicken cholera, pleuropneumonia, and many others. A few, also, produce diseases of plants, especially the rotting of bulbs and tubers. It is also claimed by careful investigators that the "fire blight" of pear and apple trees is due to the attacks of one of the bacteria.

These plants reproduce themselves chiefly by *fission*, a process which consists in the elongation of the organism to a certain point, and the formation of a cross-wall dividing it into halves, which then separate and become independent. In its essentials the process is evidently a simple cutting into two.

The bacteria are universally disseminated, since their extreme smallness and consequent lightness render them easily transportable by the lightest breezes. When it is remembered that all putrefactive changes are due to their activity, their omnipresence begins to be realized.

The true FUNGI show greater complexity of structure than either of the groups just described. With a very few exceptions, they have a distinct *plant body* or vegetative portion, on which are developed the reproductive organs, the fruiting portion. The plant body consists of fine colorless threads, often branched, which spread over or through the substance from which the fungus draws its nourishment. These active, absorbing, vegetative threads of the plant body constitute the MYCELIUM of the fungus. From these are ultimately produced others, which are the fruiting or reproductive threads of the plant, and bear the reproductive bodies whose function is similar to that of the seeds of the higher plants, namely, the perpetuation of the species. Though produced in widely different ways, and varying among themselves far more than do the seeds of flowering plants, they may be, for convenience, all included under the general name SPORES. They are much simpler

an true *seeds*, and are usually microscopic in

In the simplest cases, the spores of a fungus are produced at the ends of separate and independent fruiting threads. In other cases they are the products of sexual processes, resulting from the union of distinct male and female threads; in still other cases they are produced in more complicated forms, numerous reproductive threads being so intimately interlaced and compacted into a mass of considerable size, which bears an exterior cavity or cavities, or on some part of its surface these spore-bearing structures reach their greatest size and conspicuousness in the "toadstools" and similar forms. In the modes in which spores are developed from the fruiting threads, we may distinguish two chief types. In the first, the end of a thread is simply cut off to form a spore; in the other, the end of the thread swells, and the spores are formed free in the swollen portion. Those of the first type may be called *naked*, those of the latter, *encased*. There is another classification of the spores, which is of special importance in the study of their germination. The majority of fungus spores can germinate and produce new fungi, under favorable conditions of soil and vegetation. Of these there are some which germinate very soon, and, unless they very soon find such conditions, fail to develop. They are produced in great numbers, but, however, may develop rapidly, and serve especially to propagate the fungus by the infection of new hosts during the growing season. They may therefore be designated *active* spores. A familiar example is offered by the spores which develop in red-brown streaks on the leaves and stems of plants, in midsummer, and known as the "red rust."

Such spores can live for a long time, awaiting suitable conditions, and are ready to improve the first opportunity for germination.

Still others, on the contrary, require a greater period of rest or quiescence before germination can take place. Such spores are usually able to withstand great cold, low temperature and dryness, and serve to perpetuate the fungus through the winter or other unfavorable period; they are called the summer spores, which spread it rapidly at the beginning of the growing season. They may be distinguished as *resting* spores.

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SPORES, and well illustrated by the spores which compose the black streaks which follow the red rust on the stalks of grain, and are known as "black rust."

A few fungi form peculiar bodies, which serve the purpose of resting spores, although they are of a very different nature. These are dark-colored masses of closely compacted mycelium, which can retain their vitality for a long time under circumstances unfavorable to growth, and finally when favorable conditions recur, produce spore-bearing structures and spores. These special resting mycelia are known as SCLEROTIA, and are well illustrated by the *ergot* of grain, often known as "spurred rye."

A given species of fungus may produce, not merely one but two or several forms of spores and spore-bearing structures. These various forms may be produced at the same time or at nearly the same time, on the same mycelium; and when this is the case, their connection and relations to each other are comparatively easy to make out. For instance, the streaks of rust on the culms of grain may often be found at the proper season, with both red and black spores arising from the same mycelium, showing that the red and black rusts are only different spore-forms of the same fungus. It is so simple a condition as this is the exceptional rather than the usual one. In very many fungi, the spores produced on one mycelium develop other mycelia essentially indistinguishable from the first, on which spores very unlike the first are formed; and these may, in their turn, give rise to a mycelium bearing spores like the first. For example, the mycelia developed next spring from the spores of many black rusts of the present season will produce, not new rust spores, but chains of wholly different spores, arranged in the form of tiny circular masses, each surrounded by a fringed or ragged border. From this characteristic structure, and the fact that they usually grow in close groups, these peculiar forms of fructification have received their name of *cluster cups*. On the mycelium arising from their spores are developed again rust spores like those which gave rise to the *cluster cup* mycelium. Or again, the same mycelium may produce two or more forms of spores at quite different times, so that their connection is not directly traceable except by keeping

under long-continued observation. The pore-bearing organs in the different stages of fungus may represent wholly different types of that the different forms have been, and, in the majority of cases, still are, described and known under names, as distinct fungi. This diversity of form, of the life-cycle of so many fungi, is known as polymorphism. The subject is but just beginning to be studied and its study is only begun. Consequently our knowledge of the whole matter is extremely fragmentary and incomplete.

Like other plants, exhibit among themselves different types of structure, and may be separated into distinct groups; while, within the limits of these groups, they show in greater or less degrees that similarity of form and development which indicates descent from common ancestors, and consequent near relationship. These resemblances and differences enable us to arrange the material for convenience of study and discussion in a more or less systematic order, though our knowledge is still very far from being sufficiently complete to afford us an arrangement which fully represents their relationships. It will be convenient, in future discussions, to have a general classification of the fungi and related groups; the following is presented with a view to meeting this need, and is hoped that it may prove useful for reference, and is as fully as possible, taken in connection with the preceding chapters, to facilitate an intelligent understanding of the nature of particular fungous diseases. If any reader, after reading this necessarily very brief and sketchy account, has a desire for more detailed information concerning fungi, the writer will be glad to render all possible assistance. In the following brief accounts of the various groups, attention has been given especially to those which are parasites on cultivated plants. The best English name has been given to each group, and the Latin name will be found, in each case, between parentheses, by which the group is known to

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I. SLIME MOULDS (*Myxomycetes*). — See above, p. 20.

II. BACTERIA (*Schizomycetes*). — See above, p. 201.

III. FUNGI. — These may be conveniently divided, for our purpose, into about seventeen groups, all but the last composed of quite closely related plants, as follows:—

1. *Downy mildews* and *white rusts* (*Peronosporæ*) are internal parasites in the herbaceous parts of plants. Most of them produce summer spores, on threads which break through the surface of the plant into the air; and rest in spores, in the interior of the host. The latter are set free by the decay, during the winter, of the tissues in which they are imbedded, and then germinate in spring. The former are scattered by the currents of air, and rapidly infect new hosts.

Among diseases caused by attacks of members of this group of fungi are the potato rot, downy mildews of the grape, lettuce, onion, etc., and “damping off” of seedlings.

2. *Water moulds* (*Saprolegniaceæ*) are chiefly saprophytes on animal substances (dead insects, etc.) in water; but some of them can attack living fish, notably the salmon, destroying the skin, commonly of the head region, by its gradual spread, and finally killing its victim.

3. *Leaf-gall fungi* (*Chytridiaceæ*) are very small and simple parasites, some of which form pustule-like swellings on the herbaceous parts of flowering plants, and so merit the name here given. A majority of the members of the group, however, are parasites on the lower water plants, and of no present interest.

4. *True moulds* (*Mucorini*) comprise fungi which are saprophytes on common vegetable substances, and others which are parasites on the mycelia of the former. They are of no special interest in the present connection.

5. *Insect fungi* (*Entomophthoræ*) are nearly all parasites of insects, and cause the death of their hosts. Their only economic interest is in the possibility which has been suggested that they may be artificially propagated for use in destroying insect pests. The scheme however is one of very doubtful practicability.

6. *Smuts* (*Ustilaginæ*) are internal parasites of flowering plants, and develop both mycelium and spores in the

their hosts. The mycelium is largely used up in the spores, so that, at maturity, little is to be found as a brown or black powdery mass of spores. In these latter can germinate at once under certain conditions but they may live for a very long time ready to develop when favorable conditions occur. The spores of rusts seem to be true resting spores; and those of smuts of various species approach that condition, in that they germinate much more readily after a period of rest than after maturity. The smuts of corn, of wheat and other cereals, and of the onion, are only too well known.

(*Uredineæ*) are especially interesting for their remarkable pleomorphism, already referred to. They are very common parasites of flowering plants, and the rusts produce three chief spore forms. Individual rusts within the group make it difficult to give a general statement, but the following will apply to most of the rusts. In the first season the fungus appears in its first or *cluster-cup* form as described above, and shown in the yellow patches on barberry leaves in June. The spores of this form give rise to the fresh mycelia, which give rise to the second, and then the third, spore form. These second and third forms have already been stated, the *red* and *black* rusts respectively. This is the typically complete condition. In many cases one or even two of the forms may be present. The spores of the *cluster-cup* and *red-rust* are summer spores, while those of the *black-rust* are winter spores, though not always so.

The various forms of a rust fungus follow each other on the same host plant; but the difficulty of a complete knowledge of many of them is further complicated by the fact that the *cluster-cup* form occurs on one host, and the *red* and *black* forms on a widely different one. For example, the first stage of the fungus on barberry is the first stage of the fungus on wheat, and the second and third stages are the red and black rusts of wheat. On various other grains and grasses, as has been shown by repeated cultures. This form of pleomorphism, in which the different spore forms of a parasitic fungus occur on different hosts, is known as HETEROCISM.

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A few closely related plants belonging to the group rusts constitute important exceptions to the typical history, outlined above. These are *heteræcismal* fungi whose second form is unknown, and probably does not exist. Their cluster-cup forms cause the familiar "rust" of the leaves, and sometimes of the fruits, of apple trees, hawthorns and related woody plants, in summer; and the third forms are the "cedar apples," whose gelatinous fruit masses are equally common on our red cedars or "savin" and junipers, in spring. It will be seen from the above that the "cedar apples," which correspond to the *black-rust* stage of other rusts, appear *earlier* in the season than the *cluster-cup* stage; naturally, then, their spores are not resistant spores, the fungi being carried through the winter by their mycelia, which live in the branches of the hosts.

Among important isolated forms, whose other stages are unknown, may be named the orange-colored rust which covers the lower surfaces of the leaves of blackberries and raspberries in spring and summer.

8. *Jelly fungi* (*Tremellini*) are very interesting botanically, since they show distinct relationships with both rusts and the toadstools; but they are saprophytes, require no further notice here, beyond the statement that they form gelatinous masses of various colors, from white to black, on dead wood, and are most abundant in late fall and early spring.

9. *Toadstools* (*Hymenomycetes*) are perhaps the most abundant of fungi, besides comprising more species than any other group. They are nearly all saprophytes, and most grow in places where the presence of organized fruiting material would hardly be suspected. Their spores are borne free at the ends of spore-producing threads, which are usually packed closely together, and form a fruiting surface. In the simplest members of the group this surface is only one exposed to the air; but in the more elaborate forms, popularly known as toadstools, there are upper and under surfaces distinguishable on the fruiting structure, and of these the latter is the spore-producing surface.

A few forms are of present interest. One of the simplest members of this group causes the leaves and fruits of

cranberry, and related plants, to become swollen by a white "bloom," composed of the spores, and often does considerable damage. The several toadstools grow in the wood or between the bark of trees, and may do much harm to timber. In the case of some species, the mycelia may form branching *sclerotia*, somewhat resembling roots, but uncommon beneath the bark of decaying logs. The group includes the mushrooms, the chantarelle, and many valuable food fungi.

*Gasteromycetes* are nearly related to the *Boletales*, and, like most of its members, are saprophytes. Some species are edible, but otherwise the group has little importance, although including many familiarly known fungi.

*Saccharomycetes* are very simple fungi, in which the vegetative plant is reduced to a single elliptical cell, and which reproduce itself chiefly by a process of budding. A slight projection grows out from the cell, and gradually increases until it reaches dimensions not much less than those of the parent cell, from which it then becomes detached, and leads an independent life, budding in its turn. As saprophytes, these fungi are of great interest to the brewer, from their producing the alcoholic fermentation, and their consequent practical application in baking bread. The change known as alcoholic fermentation is the separation of the chemical elements composing sugar into alcohol and carbon-dioxide; and the power to produce this change is possessed in a remarkable degree by the yeasts.

*Exoascæ* are parasitic fungi of very common occurrence. They cause a swelling and curling of the leaves, which are commonly the leaves, though sometimes the fruits. The distortions are covered by a mass composed of tiny club-shaped sacs, projecting from the surface cells of the host, and containing spores. The "curl" of peach leaves and the swelling of plum leaves into "plum pockets" are caused by

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13. *Powdery mildews* (*Perisporiaceæ*) are external parasites of herbaceous parts of plants. The white threads of the mycelium spread over the surface, sending absorbing organs into the tissues, and bear abundantly the fruiting structures, which are recognizable by the naked eye as tiny black bodies, when ripe. Each of these bodies consists of a hard shell, surrounding from one to several somewhat egg-shaped sacs, in which the spores are contained. The best known of these fungi are the powdery mildews of the grape and the gooseberry.

14. *Black fungi* (*Pyrenomycetes*) may be so called from the fact that a large majority of them produce a blackened or carbonized appearance of the leaves or branches which they attack, making them look as though burned. Sometimes, however, they are of a light or bright color, so that the name is not entirely appropriate. In cavities in these black or colored fruiting structures are contained the spores, enclosed in oblong or club-shaped sacs, which escape into the air through tiny pores connecting with the exterior. Many of these fungi also produce summer spores, on threads which cover the outer surface with a "bloom," or bloom. In cavities similar to those which contain the spores in summer. Most of these plants are saprophytes, but a few attack living hosts still living. Of them there are a few which are well known, notably those which cause the "black-knot" of plum and cherry trees, and the "black-rot" of the grape.

15. *Saucer fungi* (*Discomycetes*) are so called from the form of the fruiting portion of many members of the group, though, on account of their wide variations, no single descriptive term is applicable to all. They are chiefly saprophytes, and the larger forms sometimes strikingly recall the toadstools in habit and place of growth. The spores are contained, as in the last two groups, in closed sacs, which, in the saucer fungi, stand erect and closely packed together on the upper or inner face of the saucer, which they cover with a distinct spore-bearing layer. A few of these fungi live, at least under certain conditions, as parasites, and develop small *sclerotia* in the tissues of their hosts, thus producing the so-called "sclerotia diseases" of clover, onions, hemp, etc.

*ffles* (*Tuberaceæ*) are a small group of subter-  
rophytes, some of which are highly prized as  
ood.

*perfect fungi* is a general term to include an  
umber of forms supposed to be mostly early  
e development of members of some of the groups  
cribed, especially various summer-spore forms of  
ging to groups 13, 14 and 15. Here are com-  
very different forms known under the names  
*æ*, *Melanconieæ*, *Hyphomycetes*, etc. The spores  
borne naked on the ends or sides of spore-  
threads, and germinate at once, as a rule. These  
in large proportion, parasites, and produce  
widely differing external appearance, known  
y the names "anthracnose," "blight," "spot,"  
ot," etc.

account of these fungi is impossible, except by  
them into several groups, because of the very  
us character of the contents of this general  
forms not placed elsewhere. The fact that such  
ous and enormous collection of "imperfect"  
s must form a part of any enumeration of fungi,  
vidence of the incompleteness of our knowledge.  
n as that knowledge increases, the extent of this  
ust diminish.

e outline covers the principal fungi, and will, it  
some extent subserve the purposes for which it  
pared. Being now in possession of some general  
ning fungi, we may attempt to deduce from them  
se principles which must guide us in attempts to  
revent the ravages of diseases caused by these

parasitic fungi develop, for the most part, within  
of their hosts, it is evident that there is little  
f saving a plant once fairly infected; for what  
he parasite would ordinarily be fatal to the host.  
y mildews, being external parasites, may perhaps  
fter they are well developed. Our chief aim,  
must be to protect the plant by the thorough  
to its exposed surfaces of some preparation which

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shall, without injuring the plant, kill or at least prevent germination of fungus spores which may alight upon it, and which would, under natural conditions, germinate there and infect the plant. Many such preparations have been proposed and tested, a few with encouraging results. While this whole subject is but little developed as yet, two forms may be given which promise to be quite generally useful.

*Copper Mixture of Gironde or Bordeaux Mixture.*

- A. Dissolve six pounds sulphate of copper (blue stone) in sixteen gallons water.
- B. Slake four pounds quicklime with six gallons water.
- C. When cool, mix A and B, stirring thoroughly.

*Blue Water or Eau Celeste.*

Dissolve one pound sulphate of copper in four gallons water; when cool, add one pint commercial ammonia and eight gallons water.

The latter of these may be applied by means of a sprayer or apparatus which thoroughly distributes it; but the former requires the use of a spraying pump, with a special agitation nozzle to keep it evenly and thoroughly mixed, since the lime is simply held in suspension, without being dissolved.

It seems hardly necessary to point out that a vigorous and healthy plant will be far less subject to the attacks of fungus and will suffer far less from such attacks, than a poor and poorly nourished one. Both theory and experience point to the obvious conclusion.

After a plant is too far gone to be saved, measures should be taken to prevent the infection of neighboring plants, and of plants of the same kind, in the following season. With the latter object in view, one should destroy the affected parts, and especially any dead or fallen parts, refuse, which may harbor the spores of the fungus during the winter. In dealing with fungi which produce resting spores, these precautions should be taken with especial thoroughness. The destruction of infectious material should be as complete as *burning* can make it, for nothing less than this will assure the death of all the spores contained in it. In dealing with any fungous disease, one of the secrets of success may be summed up in the word, *thoroughness*.

cases can be cited of common weeds or wild of which is so closely related to some species and plants that it is liable to attack by the same as its cultivated relative. Where this is true, the wild may serve equally with the cultivated one to harbor the fungus, and may keep it alive during a time when the cultivated is not grown, or may become a source of infection in a cultivated field, previously free. For example, the "black-knot" fungus grows on our wild cherries, as well as on cultivated cherries and plums; the lettuce mildew attacks several species of "wild lettuce;" and the grape-vine mildew, besides occurring on wild grape vines, has been found on the Virginia creeper. The bearing of these facts is in favor of preventing and checking the various diseases

It is clear that epidemic diseases cannot be successfully combated without general co-operation throughout the region. The attempts of half a dozen intelligent growers to protect their crops may be almost of no avail, if one "conservative" neighbor refuses to join in the effort, and allows his adjacent field to afford a breeding-place for the very fungus our progressive friends are fighting. In dealing with diseases caused by parasitic fungi, therefore, to be based on the following essentials: *thoroughness, cleanliness, intelligent treatment,*

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*who wishes to come into much more general co-operation with the farmers, market gardeners, horticulturists, and all who cultivate plants, in the State. He especially and urgently requests that specimens be sent him of all plants affected by any disease, not caused by insects, which will draw the attention of any reader of this report.*

*Such aid to a fuller knowledge of many diseases can be secured if those who are the losers by them will co-operate by giving the possible assistance, even to the extent of going to the field, to those engaged in their study. Without such cooperation and assistance, our work must necessarily be ineffective and our studies far less complete in their*

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## 2. *The Potato Scab.*

In the report of this station for 1888, pages 131 to 132 was given an account of the disease of potatoes known as "scab," with a summary of the views held up to that time as to its nature and cause. It was shown that, while the characters of the disease are sufficiently marked and too familiar, its cause is still to be explained. On this point three principal theories are held, which may be stated briefly as follows: (1) the theory of W. G. Smith and others, that the trouble is caused by the irritating action of foreign substances in the soil; (2) the view that it is due to peculiar soil conditions; and (3) Brunchorst's claim that it is caused by the attacks of a parasite belonging to the slime moulds. Various American experiments were quoted bearing on the effects of the presence or absence of manure, excess or deficiency of water, use of smooth or scabbed "seed," use of fungicides, and cultivation of light or dark skinned potatoes.

In the spring of 1889, arrangements were made for experiments on the same plot on which the scab had appeared for several years, — Field E, containing about three tenths of an acre. This plot, which had been ploughed the previous fall, was ploughed again in the spring, and divided into twenty-eight sections of three rows each, each section being regarded as the unit, and each section being treated, as nearly as possible, in a uniform manner.

The whole plot, excepting section 1, at the south end, was dressed with an application of ground bone and potash and magnesia sulphate, at the rate of 600 pounds of the former and 290 pounds of the latter per acre. In addition to the suggestions for the details of experiments drawn from current theories and previous experiments, two were adopted from other sources; namely, to test the effect of tobacco applied in the drill in the form of ground tobacco refuse, and to observe the results, as to the development of scab, of deep planting. Arrangements were made to facilitate the irrigation of a part of the sections; but, owing to extreme rainfall of the season, no use was made of the means provided, and no comparison of the effects of ex-

y of moisture on the development of the scab  
tuted, as the whole field received the same  
al watering.

ive columns of the following table show the  
e planting of each section. It will be seen that  
rds material for the following comparisons of  
the development of scab: 1. Deep *vs.* shallow  
Susceptibility to attack of light and dark  
eties; 3. Barn-yard manure *vs.* commercial  
t. Effect of tobacco dust in drill; 5. Scabby  
“seed.”

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Quality of Seed.	Variety of Seed.	How Fertilized.	How Planted.	Scabiness of Crop.
1 Smooth, . . .	Beauty of Hebron, . . .	Barn-yard manure, . . .	In hills, . . .	Very badly scabbed.
2 " . . .	" . . .	Bone and potash, . . .	In drill, . . .	Considerably scabbed.
3 " . . .	" . . .	" . . .	" . . .	Considerably scabbed.
4 " . . .	" . . .	" . . .	" . . .	Badly scabbed.
5 " . . .	" . . .	Bone, potash and tobacco, . . .	" . . .	Badly scabbed.
6 Scabby, except bl'k,	1st and 2d rows, Beauty of Hebron; 3d row, $\frac{1}{2}$ white, $\frac{1}{2}$ black,	Bone and potash, . . .	" . . .	Badly scabbed, except bl'k.
7 Scabby, . . .	1st row, Beauty of Hebron; 2d and 3d rows, white, . . .	" . . .	In trench (deep), . . .	Considerably scabbed.
8 Smooth, . . .	Beauty of Hebron, . . .	" . . .	In trench, . . .	Somewhat scabbed.
9 " . . .	" . . .	" . . .	In drill, . . .	Badly scabbed.
10 " . . .	" . . .	" . . .	" . . .	Considerably scabbed.
11 " . . .	" . . .	" . . .	" . . .	Considerably scabbed.
12 " . . .	" . . .	" . . .	In trench, . . .	Considerably scabbed.

17	"	"	"	"	"	"	"	"	Badly scabbed.
18	"	"	"	"	"	"	"	"	Considerably scabbed.
19	"	"	"	"	"	"	"	"	Considerably scabbed.
20	"	"	"	"	"	"	"	"	Badly scabbed.
21	"	"	"	"	"	"	"	"	Considerably scabbed.
22	"	"	"	"	"	"	"	"	Considerably scabbed.
23	"	"	"	"	"	"	"	"	Considerably scabbed.
24	"	"	"	"	"	"	"	"	Considerably scabbed.
25	"	"	"	"	"	"	"	"	Somewhat scabbed.
26	"	"	"	"	"	"	"	"	Somewhat scabbed.
27	"	"	"	"	"	"	"	"	Considerably scabbed.
28	"	"	"	"	"	"	"	"	Considerably scabbed.

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The scabby "white" potatoes planted on sections 6, 7, 13 were of a very light-skinned sort, much resembling Gregory, though not certainly of that variety. Those called "black," planted on section 6, were a very few smooth, elongated, dark-purple tubers, found in the station but not in the field. The "tops" showed the same dark color which marked the tubers, and produced the only entirely smooth potatoes on the field. The plot was planted May 4, and the first shoots broke through the soil on the 17th. A week later they were well up, and a marked backwardness of sections 1 and 13 was observed, as compared with the rest. The retarding effect of planting directly on manure continued to be distinctly noticeable for three weeks longer. Various explanations may be offered, however, for this fact, which, by itself, has no special significance. The field was cultivated and hoed at sufficiently frequent intervals, and the plants grew well, being kept fairly free from the potato beetle by light applications of Paris green, combined with hand-picking.

On the 4th of June young tubers were found, of the size of a pea, and from this time their size and number rapidly increased. On July 22 the first indications of the rotting of their appearance on the leaves of some plants near the south end of the plot, and had soon spread over almost the entire field. As soon as possible, namely, on the 29th of July, the potatoes were dug, in order to avoid the loss of results from the scab experiments to which the rotting of the tubers would lead. The potatoes from each section were kept distinct, and carefully examined with reference to their relative scabbiness. The result in each case is briefly stated in terms of a scale of five grades, running from "generally smooth" to "very badly scabbed," in the last column of the foregoing table. A compilation of the results there given with regard to their bearing on the points before indicated shows that: 1. Deep planting appears to tend to diminish the development of scab, though further experiments in this direction are very desirable. 2. While the very early potatoes were wholly free from scab, little or no difference was to be noticed in the susceptibility of the three late varieties planted; it is to be regretted that none of the

were available for the comparison. 3. The tubers on barn-yard manure were markedly more deeply scabbed than the rest. 4. Tobacco manure had no appreciable effect in increasing or decreasing the scab. 5. Scabby "seed" produces a crop no better nor worse than that grown from smooth seed. None of these results are new, but they may serve as material on which to base general conclusions, and the variety of the results of most previous similar experiments shows that all such results are comparatively without value so long as the *cause* of the trouble remains unknown. We are as much as ever in the dark, so far as rational experimentation or treatment is concerned, and therefore the most attention has been given to the development of the scab.

From the time when tubers began to be formed till the end of the season, plants were taken up at intervals, and carefully examined. The first suspicious spots were found on tubers June 20, and the first unmistakable scab on the 28th. After this time abundant specimens were obtained. It is worthy of note that the first examples of scabbed tubers were obtained from sections 1 and 14, on which no hard manure was used, and that they always came from the most and scabbiest material.

The disease always begins in very small spots, and spreads gradually. When quite small, the spots usually show dark central spots from which the lighter marginal portions seem to radiate outward. These dark central spots mark the position of the *stenticels* of the tuber, in which the disease first begins. The microscopic structure of the diseased spots is the same at all stages of their development. The first spots, detected June 20, on very young tubers, were found on microscopic examination, to be young scab-spots, and could not be distinguished in minute structure from the spots found on a full-grown tuber. The characteristic scab produces the appearance and condition known as scab in the browning, drying and shrivelling of the outer few layers of the surface cells of the tuber, and forms a hard and rough crust. The difference between a small spot and a large patch of scabby surface

is wholly one of kind, the latter developing from the former by the simple extension of the pathological condition described, over a greater surface. In this way is produced what may be described as the *superficial* form of the disease, illustrated by the lower specimen in Fig. 1, opposite page 136 of our report for 1888, and by Fig. 1, accompanying the present paper. The drying and browning sometimes penetrates to a considerable depth, and causes the death of masses of tissue of some volume, which finally become destroyed by decay, frequently with the assistance of worms and other animals. Their presence in this form of the disease has apparently led to the belief, held by many persons, that such animals are the cause of the trouble. This may be called the *deep* form of the scab, and shows in its completest development, extensive cavities in the tubers where tissue has died and decayed. It is illustrated by the upper specimen in Fig. 1 of last year's report, and by the accompanying Fig. 2. Both forms of the disease come under various conditions to such a degree that the conditions determining the development of the deep form are wholly indefinable.

Very careful examinations were made, to determine whether the present disease is caused by any plant or animal, either as a true parasite or otherwise; but no organism of any sort was found constantly or even frequently present at any stage of its progress, and there can be no doubt that it is *not* the result of the activity or development of any living thing other than the potato plant. Various experiments, referred to in the paper in last year's report above mentioned, have pointed to this conclusion, and the results would be very puzzling had the present investigation resulted otherwise. The search for some organism standing in causal relation to the trouble, has, however, been conducted with much care, in deference to the claims and theories of Brunchorst, quoted above, and to be discussed later.

Since the scientific name of an organism indicates almost a definite and determinable thing, one can always be sure in the study of a disease plainly caused by a plant or animal as to the validity of his comparisons of his results with those of others who have studied the same disease. But

"Schorf" and "Skurv" are not terms which designate finite things, but are of popular and general use, and the assumption that they are used in different countries to designate the same disease, remains an assumption until it is proved by direct comparison.

Indeed, the assumption that the word "scab" is used throughout our own country, for the same affection, is hardly justified; but, as it is borne out by experience from various parts of New England, its correctness in the whole country is taken for granted. In order to settle the uncertainty whether the three words are synonymous, two leading writers on the potato were requested to furnish material for comparison in *scabby* potatoes. Dr. Sorauer, director of the botanical station at Proskau, Germany, was asked to furnish potatoes affected with the disease known in Germany as "Grind," and Dr. Brunchorst of Bergen, Norway, was asked to furnish potatoes attacked by the disease known in Norway as "Skurv," and said by him to be caused by a different kind of mould. Both very kindly responded, and I wish here to extend to both botanists his very thanks for their interest and assistance.

I have sent several tubers affected with what, to the best of my knowledge, resembles in all respects our *superficial* form of scab. A microscopic examination fully establishes its identity with our disease. The accompanying Fig. 3 is a photograph of one of the potatoes sent by Dr. Sorauer. The German "Schorf" and the English "scab" are synonymous, as applied to diseases of the potato.

Dr. Brunchorst, a photograph of tubers attacked by the disease has been received; but, unfortunately, the quality of such tubers, promised by him, have failed to arrive, and it is impossible to accurately compare them with our own. Such comparisons as are rendered possible by Dr. Brunchorst's descriptions and figures and a photograph he has had the goodness to send, lead to the conclusion that he is dealing with a disease distinct from the *scab*, and that his assumption that American and German diseases are identical is incorrect.

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Fig. 4 is a reproduction of Brunchorst's photograph. Until more positive evidence can be obtained from study of specimens, it seems safest to assume that "Skurv" studied by him is quite different from the other diseases, and of different origin. This view removes difficulties not readily explained otherwise.

Bulletin No. 34 of this station, published last June, contained a series of questions concerning potato scab addressed to farmers, especially those of this State, who they were requested to answer from their experience, with the assistance of this department in the study of the disease. Some ten thousand copies of this bulletin were sent out, and some agricultural journals showed their interest in printing and calling attention to them. The replies to this widely circulated request were *six* in number, and of these, *four* came from neighboring States. It is interesting to ask the farmers of Massachusetts to imagine how great is the encouragement derived from such a result by those who are working in their interest, and wish their co-operation and assistance. The facts stated require no comment.

In conclusion, it may be remarked that the results of the year are more negative than positive. It is certain that the disease is the same as that discussed by German writers, and that it is not caused by any parasitic organism.

Several years' observations at this station point, also, to the correctness of the view that the cause of our trouble is to be sought in peculiar physical or chemical conditions of the soil, though the opinion that excessive moisture is a sufficient controlling cause seems hardly tenable.

It seems to be generally conceded that potatoes become most scabby in heavy, close soil, and least so in light, loose soil; that worse crops in this respect are raised on land which has been cultivated for some time than on fresh, broken ground. Indeed, the belief is quite general that new soil will give a smooth crop. This was not the case, however, at this station, the past season, when land broken for the first time in years gave a badly scabby crop. It should be added that this was on a stiff, heavy, poorly drained soil.



**FIG. 1.**

**"Surface" Scab, from Station Plots.**



**FIG. 2.**

**"Deep" Scab, from Station Plots.**

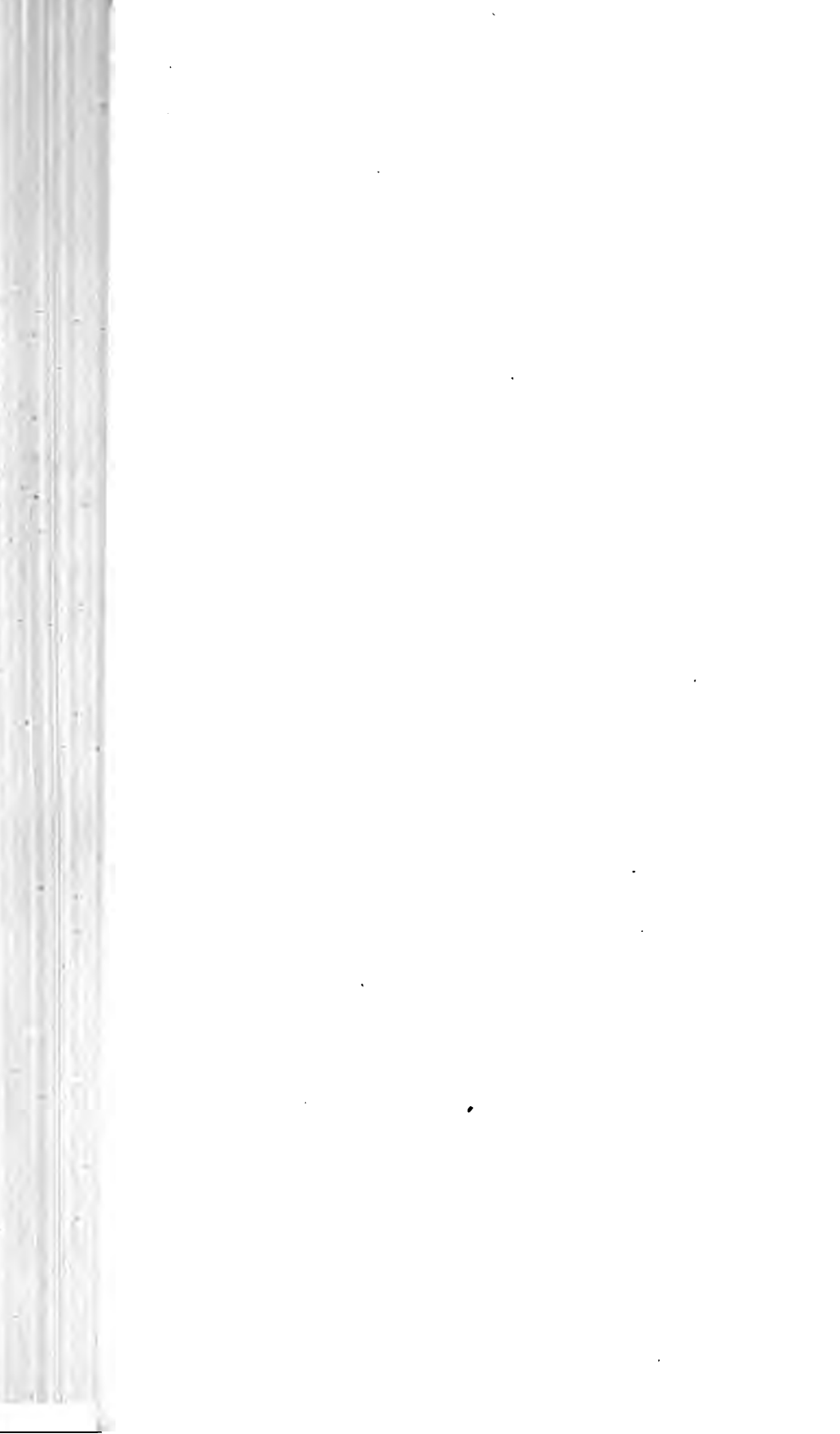




FIG. 3.

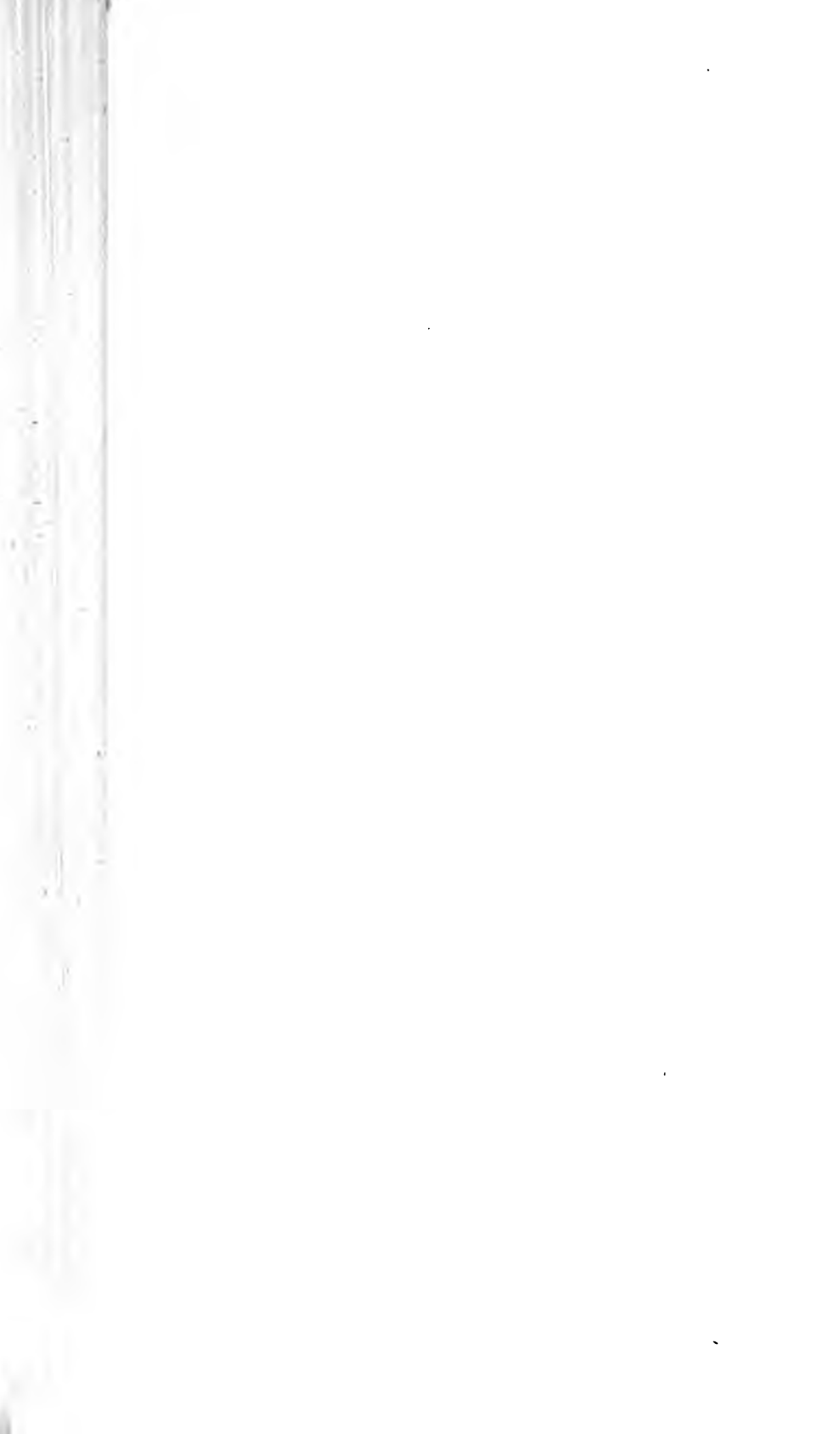
German *Schorf* (= "Surface" Scab.)



FIG. 4.

Norwegian *Skurv*.

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present probable that excess of moisture tends to the scab, rather through its influence in rendering heavy and clinging, than in any more direct manner. It is recommended that, to secure a smooth crop, be planted in light, porous soil, kept well stirred. This will be continued next season, in the light of experience.

### *Fungous Diseases on Station Farm.*

My notes include only such diseases as attacked crops on the station farm during the past season with sufficient force to produce results of economic importance. Of course, many were found, whose presence was of great importance to the various plants on which they grew, but a few produced striking results by their vigor. The meteorological conditions of the past season were peculiarly favorable to the development of

the smut of barley and oats (*Ustilago segetum* Pers.\*) on some of those grains on the east fields and on the west plats to such an extent that the "smutted" portion was a very appreciable portion of the whole. Even in the best heads but a small fraction of one per cent. of the loss on a large field would be sufficient to make it not worth saving, as a little calculation will show. The smut under consideration appears on the fruiting spikes of small grains, and, when ripe, presents only the black spores characteristic of the smuts, which compose the substance of the seed. The enclosing husk first opens, and the spores are carried in all directions by the wind, finding lodgement on the surrounding plants. Although the smut spores ripen considerably before the grain in the sound heads, grain in the field is sure to have them adhering to its ends, and entangled in the tuft of hairs at its end, especially in the case of heads that have been mixed with the sound ones.

Unless they are present in very large numbers,

it is maintained that the scientific name of a plant consists of three parts, the name of the genus, or group of closely related plants to which it belongs, the name of the species, and the name (in full or abbreviated) of the person to whom it owes the name.

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they cannot be detected by the unaided eye. These spores remain unchanged during the winter, and are ready for germination with the seed, when it is planted in the spring. Experiments have shown that the germinating tubes of the smut fungus can penetrate and infect the plants of grain when they are very young seedlings, with very tender and easily penetrable tissues. Having once gained entrance into the interior of such a plant, however, the fungus grows within the plant, invading the new tissues as they are formed, finally reaching its complete development by producing its reproductive bodies in the place of the destroyed reproductive bodies of its host. If the grain, with adhering spores, be fed to horses or cattle, the spores pass through the body and are voided unharmed. And not only are they unharmed; their passage through the animal body seems to cause them to germinate more readily than before. When they produce, in the manure heap, tiny bodies which increase rapidly by a process of budding similar to that of the yeast fungi. Thus a few spores may produce, in a short time, a multitude of these tiny buds, each of which can infect a grain seedling with the smut parasite.

Since the infection of neighboring plants cannot be prevented by a "smutty" plant, the problem of dealing with the present trouble is much simpler than similar problems concerning the numerous fungi which spread rapidly by such means as spores. It is evident that it is useless to attempt to save a plant once attacked by smut; but the facts just stated concerning the fungus under discussion point to three lines of defence against its attacks: (1) The conditions for the germination of the seed and the growth of the seedling should be as favorable as possible, in order that the period of susceptibility to infection may be made as short as possible. To this end, well-matured seed should be sown on rich, well-prepared and well-drained soil, in favorable "growing" weather. (2) Suitable commercial fertilizers should be used, and animal manures, on fields to be sown to grain. This will eliminate from the problem an important complication. The seed grain should be treated, before being sown, with a preparation which will kill the adhering spores, with the least damage to the seed. The best for this purpose is

half per cent. solution of sulphate of copper, dissolving it in water in the proportion of one to twenty-five gallons. The grain should be treated with this solution, and allowed to soak in it twelve to twenty-four hours. It may then be dried for a few hours, till dry enough to be readily treated. This treatment is very efficacious and inexpensive.

The *spot disease* of sugar beets appeared on the leaves about the end of June, in the form of dead, dry, patches, from one-eighth to three-eighths of an inch across.

These patches are the result of the death of the leaves, caused by their invasion by a fungus. While a few patches would do little harm on the leaves of a beet, they often become so abundant, as in some cases, as to destroy a large part of the tissue of the leaves. Since, as we have seen, the leaves, being the assimilating organs, are those on which the plant obtains its supply of organic food material, it is evident that the loss for the plant must be the loss, during its time of growth, of a large fraction of its working leaf surface. In the case under notice, the spots gradually increased, until, in August, the leaves were almost entirely killed by the violence of the attack. By this time, however, the roots were so well grown that they were able to produce promptly a fresh growth of leaves, which continued through the rest of the season, though themselves somewhat affected by the *spot*. Clearly, the production of this new growth must have involved the conversion, for that purpose, of a considerable amount of stored material from the roots, which ought to have remained there. This loss, with the diminution of active surface on both sets of leaves, very materially reduce the amount of solid matter in the roots, and lessen their feeding value in pro-

These forms appeared on the spots on the station of them belonging to the *Imperfect Fungi*. Up to the 10th of July, the most abundant form was that which corresponds to *Septoria Betae* West., while after that time the form, and, late in the season, apparently the same as that known as *Cercospora beticola* Sacc. In



view of their appearance on the same spots, and in the relations described, it is pertinent to inquire if they may be forms of the same pleomorphic fungus. Direct proof, either for or against this hypothesis, is, however, wanting.

No very definite directions for combating this trouble can be given, in the absence of more complete knowledge of the accompanying fungus forms than we yet have. Both *Septoria* and *Cercospora* spores quickly germinate and infect new hosts, that is, are summer spores, it is probable that spraying the crop as soon as the spots begin to appear may check its spread. It is probable that the "Eau Celestine" would give good results. Leaves badly attacked should be burned; all refuse should be cleared from the field at the end of the season, and burned; and the same crop should not be planted on the same ground or in its immediate neighborhood, the following year.

3. The *rot* of potatoes has been unusually serious on our station plots, as throughout the State, during the season just past. This disease, known as *blight* when it attacks the leaves and as *rot* when the tubers are affected, is due to a fungus of the downy mildew group, *Phytophthora infestans* de Bary. Its abundance and destructiveness in 1889 have called for many descriptions and recommendations concerning the fungus and means for checking it, that an extended account is superfluous here. The fungus spreads very rapidly by means of summer spores, but, so far as is known, does not, like most of the downy mildews, produce resting spores. Its only known mode of passing the winter is by the hibernation of its mycelium in the host tubers. Special care should be taken, then, to avoid planting "seed" potatoes which contain this hibernating mycelium, whose presence is commonly indicated by dark-brown sunken spots on the surface of the tuber, beneath which the tissues are more or less "rotted." A fuller account of this very fatal disease, by the present writer, may be found in Bulletin No. 1 of the Hatch Experiment Station of the Massachusetts Agricultural College.

The blight which appeared on the leaves of potatoes in the plot devoted to *scab* experiments, as previously

and rapidly, but not with perfect regularity. Leaves and stems were mostly killed by the fourth day after its appearance, those on sections 14, the third row of section 6, and the second rows of both 7 and 13, were still fresh and unharmed. Comparison with the table given shows that the sections which suffered least were those in which the potatoes were planted directly on manure, and those which were planted with the varieties designated *white* and *black*. That some varieties are less susceptible than others to attacks of the rot, has been known for some time; but why planting on manure should give immunity against it, as seems here to have been the case, is not yet to be seen; yet there was no other difference in the results between plots 1 and 14, on one hand, and 2-4, 5-16, on the other hand. Yet all the latter were killed very severely. The attack was not of the violent sort, and, even on the worst-affected plots, the plants were not the complete collapse into a slimy mass, which is the result of the extreme form of the rot. Nothing now remained to be done but to harvest the potatoes as quickly as possible. Presses of other varieties attracted immediate attention, but they were all saved before the end of the month, in very good condition, as the rot was concerned. Later potatoes, especially those which received less prompt attention, were a great loss.

Other fungous diseases are reserved until more material has been accumulated concerning them.

#### *Material referred to the Department.*

The examinations which have been made by the Department of specimens referred to it, may be of sufficient interest to warrant a brief discussion here.

*Rot in Cellar.* — In December, 1888, a quantity of tuberculent substance, mixed with gravel from the cellar in which it had grown, was sent in for examination from a house from whose cellar the material was taken. The growth in question was a white, fleshy substance, and the white growth in question was a great alarm to the tenants, who threatened to

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leave, fearing that its appearance was an indication of unhealthfulness of the premises.

It was evident to the unaided eye, and microscopic examination confirmed the opinion, that the white material was the sterile mycelium of some fungus. As there was no sign of spore formation, it was impossible to say to what fungus the mycelium belonged, though more probably to some member of the toadstool group.

The only conditions necessary to the development of fungus mycelia are the presence of spores, and of certain degree of temperature and moisture. The latter condition is afforded by even the best of cellars, which receive no artificial heat, and fungus spores penetrate every crevice in the air in which they float. Not only are such growths perfectly harmless in themselves, but their occasional appearance is no indication of unhealthful conditions, although their very constant or luxuriant appearance is often an accompaniment of extreme dampness. For the sake of neatness, it is best to remove them with a stiff broom, and prevent their reappearance on the same surface by the free application of lime, either dry or in the form of whitewash.

A report to this effect was made in the present case, and it was afterwards learned that the tenants had all been left, victims to their superstitious fears and dread of the "mysterious."

It should be remarked here that the appearance of white fungus mycelia, followed by the development, on the surface of the mass, of a rusty-brown spore layer, with the exudation of watery drops at its margin, should receive particular attention. The fungus which answers to this description belongs to the toadstool group, and appears on woodwork or even on cellar bottoms. It produces a very rapid and destructive "dry rot" of timber, and is known in Germany as the "house fungus." It should be thoroughly destroyed, and all woodwork in its vicinity painted or well whitewashed.

2. *Black Spot of Rose Leaves.* — A disease affecting the leaves of roses growing in the Durfee plant-house of the Massachusetts Agricultural College was referred by Mr. S. T. Maynard to this department for examination.

ember, 1888. The leaves showed the dark, endritic patches, and the small, slightly raised characteristic of the "black spot" of the rose; and he showed the presence of an abundant mycelium producing at certain points masses of the spores "black-spot" fungus, *Actinonema rosæ* Fr. The spots are indicated by the pustules, which are the elevation of the surface layer or *epidermis* of the developing spore masses. As the internal leaf is invaded by the mycelium, it is gradually loses its green color; so arise the discolored give the disease its name, and which, at first radially in all directions from the point of the fungus which causes this trouble is one of fungi, and its relation to other forms remains un-  
ruined.

This disease appeared abundantly on leaves of roses at of doors in the garden of a very successful hmerst, last summer.

aves should be carefully collected and destroyed, the dissemination of spores; and it is probable with some fungicide will prove efficacious in disease, if done early and frequently enough. tails and recommendations, reference may be report of the mycologist of the United States of Agriculture, for 1887, p. 366, and to Bulletin Hatch Experiment Station, before referred to. *Worm Disease of Cucumbers.* — A disease seri- g cucumbers raised under glass came to my July last, through Mr. H. T. Fernald of t manifests itself first in the yellowing of the n is followed by the death of the plant. But of trouble is in the roots, on which are formed le-like swellings or *galls*, in which the tissues are ngy, and easily crumble. Examination showed in these galls of very numerous microscopic air eggs. The worms measure perhaps one- inch in length, and belong to the group known rms or *nematodes*, which attack the roots of with fatal results.

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This nematode disease of cucumbers is known in England and is said to have been successfully treated by watering the soil in which the diseased plants were growing, with a weak solution of permanganate of potash, which appears to be fatal to the worms, without injuring the plants. It is suggested that the sulphate of manganese would probably be as efficient as the permanganate of potash, while it is cheaper. The writer will be glad to communicate with any one who is troubled by this disease, and wishes to experiment in combating it.

## 2. — COMMUNICATION BY C. A. GOESSMANN.

The investigations concerning the effect of various methods of cultivation and of manuring on the general character and composition of fruits and garden crops will be resumed as far as practicable, during the coming year. The circumstances which some years ago obliged me to discontinue that work as outlined in our first and second annual reports under the heading "Chemistry in Fruit Culture," are no longer existing now. The late permanent assignment of suitable fields, as well as the recent erection of buildings designed with a view to offer to growing plants the necessary protection against objectionable features of climate and weather, promise to favor our plans of operation. The co-operation of our experiments in the field and in the vegetation cannot fail to assist materially in drawing correct conclusions from our results.

## AL WORK IN THE CHEMICAL LABORATORY.

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ication on commercial fertilizers :—

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aws for the regulation of the trade in commercial  
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analyses of licensed fertilizers.

analyses of commercial fertilizers and manurial sub-  
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s, fruits, sugar-producing plants, dairy products, etc.

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## I. COMMUNICATION ON COMMERCIAL FERTILIZERS.

1. General introduction.
2. Laws for the regulation of the trade in commercial fertilizers.
3. List of licensed manufacturers for May 1, 1889, to May 1890.
4. Analyses of licensed fertilizers.
5. Analyses of commercial fertilizers and manurial substances sent on for examination.
6. Miscellaneous analyses.

*1. General Introduction.*

The new duties assigned to the director of the station render it necessary to discriminate, in the future, in official publications of the results of analyses of commercial fertilizers and of manurial substances in general, between analyses of samples collected by a duly qualified delegate of the experiment station, in conformity with the rules prescribed by the new laws, and those analyses which are made of samples sent on for that purpose by outside parties. In regard to the former alone can the director assume the responsibility of a carefully prepared sample, and of the identity of the article in question.

The official report of analyses of compound fertilizers, and of all such materials as are to be used for manurial purposes which are sold in this State under a certificate of compliance with the present laws for the regulation of the trade in these articles, has been restricted by our State laws to a statement of chemical composition, and to such additional information as relates to the latter. The practice of affixing to each analysis of this class of fertilizers an approximate commercial valuation per ton of their principal constituents, has, therefore, to be discontinued. This change, it is expected, will tend to direct the attention of the consumers of fertilizers more forcibly towards a consideration of the particular composition of the different brands of fertilizers offered for their patronage, — a circumstance not unfrequently overlooked.

The approximate market value of the different brands of fertilizers, obtained by the current mode of valuation, does not express their respective agricultural value, *i.e.*, the

ing value ; for the higher or lower market price brands of fertilizers does not necessarily stand in relation to their particular fitness, without any the particular condition of the soil to be treated, special wants of the crops to be raised by their To select judiciously from among the various fertilizers offered for patronage, requires, in the hands of information ; namely, we ought to feel that the particular brand of fertilizer in question contains the guaranteed quantities and qualities of elements of plant food at a reasonable cost, and that them in such form and in such proportions as meet existing circumstances and special wants. It may be mainly either phosphoric acid or potash ; in others, two of them ; and in others three. A remunerative use of commercial fertilizer may be secured by attending carefully to the following considerations.

For farmers not yet familiar with the current mode of valuing the commercial value of manurial substances available in our markets, some of the essential considerations which serve as a basis for their commercial valuation are more fully stated within a few subsequent pages. The customary valuation of manurial substances is based on the average trade value of essential fertilizing ingredients as ascertained by analysis. The money value of the elements of agricultural chemicals, and of the higher-grade fertilizers, depends, in the majority of cases, on the amount and the particular form of two or three elements of plant food—i.e., phosphoric acid, potash—which they contain. To ascertain, by analysis, the valuation, the approximate market value of a fertilizer, the money worth of its essential fertilizing ingredients, we multiply the pounds per ton of nitrogen, by the trade value per pound ; the same course is followed with reference to the various forms of phosphoric acid and potassium oxide. We thus get the values per ton for several ingredients, and, adding them together, get the total valuation per ton in case of cash payment for general distribution.

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The market value of low-priced materials used for nurial purposes, as salt, wood ashes, various kinds of barn-yard manure, factory refuse, and waste material of different description, quite frequently does not stand in close relation to the market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation and more or less advantageous mechanical condition of the material, and the speedy action, exert, as a rule, a decided influence on the selling price.

The mechanical condition of any fertilizing material, simple or compound, deserves the most serious consideration of farmers, when articles of a similar character are offered for their choice. The degree of pulverization controls almost without exception, under similar conditions, the rate of solubility and the more or less rapid diffusion of the different articles of plant food throughout the soil. The state of moisture exerts a no less important influence on the pecuniary value, in case of one and the same substance. Two samples of fish fertilizers, although equally pure, may differ from fifty to one hundred per cent. in commercial value, on account of mere difference in moisture.

Crude stock for the manufacture of fertilizers, and raw materials of various descriptions, have to be valued with reference to the market price of their principal constituents, taking into consideration, at the same time, their general fitness for speedy action.

*Trade Values of Fertilizing Ingredients in Raw Materials of Chemicals. (1889.)*

	Cents per
Nitrogen in ammoniates, . . . . .	100
Nitrogen in nitrates, . . . . .	100
Organic nitrogen in dry and fine-ground fish, meat and blood, . . . . .	100
Organic nitrogen in cotton-seed meal and castor pomace, . . . . .	100
Organic nitrogen in fine-ground bone and tankage, . . . . .	100
Organic nitrogen in fine-ground medium bone and tankage, . . . . .	100
Organic nitrogen in medium bone and tankage, . . . . .	100
Organic nitrogen in coarser bone and tankage, . . . . .	100
Organic nitrogen in hair, horn shavings and coarse fish scraps, . . . . .	100
Phosphoric acid soluble in water, . . . . .	100
Phosphoric acid soluble in ammonium citrate, . . . . .	100

*Values of Fertilizing Ingredients — Concluded.*

	Cents per Pound.
id in dry ground bone, fish bone and tankage, . . .	7
id in fine medium bone and tankage, . . . . .	6
id in medium bone and tankage, . . . . .	5
id in coarse bone and tankage, . . . . .	4
id in fine-ground rock phosphate, . . . . .	2
-grade sulphate, and in form free from muriates	
; ashes, etc., . . . . .	6
ite, . . . . .	4½
iate, . . . . .	4½

ic nitrogen in superphosphates, special manures fertilizers of a high grade, is usually valued at figures laid down in the trade values of fertilizing in raw materials, namely, nineteen cents per being assumed that the organic nitrogen is derived st sources, viz., animal matter, as meat, blood, her equally good forms, and not from leather, r, or any low-priced, inferior form of vegetable ess the contrary is ascertained. For similar insoluble phosphoric acid is valued in this con-ree cents; it being assumed, unless found other-is from bone or similar source, and not from nate. In this latter form the insoluble phos-is worth but two cents per pound.

the trade values are the figures at which, in the preceding March, 1889, the respective ingredi-be bought at retail for cash in our large markets, materials, which are the regular source of supply. correspond to the average wholesale prices for the ending March 1, plus twenty per cent. in case of hich we have wholesale quotations. The valua-ed by use of the above figures will be found to with the retail price at the large markets of v materials, such as —

ate of ammonia, .	Dry ground fish,
ate of soda,	Azotin,
ate of potash,	Ammonite,
ate of potash,	Castor pomace,
blood,	Bone and tankage,
ground meat,	Plain superphosphates.

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A large percentage of commercial materials consists of refuse matter from various industries. The composition of these substances depends on the mode of manufacture carried on. The rapid progress in our manufacturing industries is liable to affect, at any time, more or less seriously, the composition of the refuse. To assist the farming community in a clear and intelligent appreciation of the various substances sold for manurial purposes, a frequent examination into the temporary character of agricultural chemicals and refuse materials offered in our markets for manurial purposes is constantly carried on at the laboratory of the station.

Consumers of commercial manurial substances do well to buy, whenever practicable, on guaranty of composition with reference to their essential constituents; and to see to it that the bill of sale recognizes that point of the bargain. Any mistake or misunderstanding in the transaction may be readily adjusted, in that case, between the contending parties. The responsibility of the dealer ends with furnishing an article corresponding in its composition with the lowest stated quantity of each specified essential constituent. Our present laws for the regulation of trade in commercial fertilizers include not only the various brands of compound fertilizers, but also all materials, single or compound, without reference to source, used for manurial purposes, when offered for sale in our market at ten dollars or more per ton.

Copies of our present laws for the regulation of the trade in commercial fertilizers may be had by all interested, on application at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.

Arrangements are made, as in previous years, to attend to the examination of objects of general interest to the farming community, to the full extent of existing circumstances. Requests for analyses of substances, as food articles, fertilizers, etc., coming through officers of agricultural societies and farmers' clubs within the State, will receive hereafter, as in the past, first attention, and in that order that the applications arrive at the office of the station. The results will be returned without charge for the service rendered. Applications of private parties for analyses

free of charge, will receive a careful consideration. However the results promise to be of a more general nature. For obvious reasons, no work can be carried on in the State of which the results are not at the disposal of the State for publication, if deemed advisable in the interest of the citizens of the State.

Reports and communications sent on to "The Massachusetts State Experiment Station" must have express and postal charges prepaid, to receive attention.

*for the Regulation of the Trade in Commercial Fertilizers.*

[CHAP. 296.]

TO REGULATE THE SALE OF COMMERCIAL FERTILIZERS.

*1, etc., as follows:*

Every lot or parcel of commercial fertilizers or manures for manurial purposes sold, offered or exposed for sale in this Commonwealth, the retail price of which is ten dollars or more per ton, shall be accompanied by a plainly printed label, clearly and truly certifying the number of net pounds of the package, the name, brand or trade mark under which it is sold, the name and address of the manufacturer or the place of manufacture, and a chemical analysis stating the percentage of nitrogen or its equivalent in ammonia, of phosphoric acid in distilled water, and of phosphoric acid in available form in distilled water and reverted, as well as the percentage of phosphoric acid. In the case of those fertilizers which contain cheap and cheaper materials, said label shall give a correct statement of the composition and ingredients of the fertilizers and companies.

Before any commercial fertilizer, the retail price of which is ten dollars or more per ton, is sold, offered or exposed for sale, the importer, manufacturer or party who causes it to be sold for sale within the state of Massachusetts, shall file with the director of the Massachusetts agricultural experiment station a certified copy of the statement named in section one of this chapter, and also deposit with said director at his request a sealed bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample.

The manufacturer, importer, agent or seller of any commercial fertilizer or material used for manurial pur-

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poses, the retail price of which is, ten dollars or more per ton, shall pay for each brand, on or before the first day of May annually, to the director of the Massachusetts agricultural experiment station, an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus and potassium contained or claimed to exist in said brand or fertilizer: *provided*, that whenever the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller of such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on receipt of said analysis fees and statement specified in section two, the director of said station shall issue certificates of compliance with this act.

SECT. 4. No person shall sell, offer or expose for sale in this state of Massachusetts, any pulverized leather, raw, steam, roasted, or in any form as a fertilizer, or as an ingredient of fertilizer or manure, without an explicit printed certificate of fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure and to accompany or go with every parcel or lot of the same.

SECT. 5. Any person selling, offering or exposing for sale, commercial fertilizer without the statement required by the section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence, and one hundred dollars for each subsequent offence.

SECT. 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use, and not to be sold in this state.

SECT. 7. The director of the Massachusetts agricultural experiment station shall pay the analysis fees, as soon as received by him, into the treasury of the station, and shall cause one analysis or more of each fertilizer or material used for manurial purposes to be made annually, and publish the results monthly, with such additional information as circumstances advise: *provided*, that the information relates only to the composition of the fertilizer or fertilizing material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or any material used for manurial purposes which may be in the possession of any manufacturer, importer, agent or dealer; said sample shall be drawn in the presence of said party or party in interest or their representative, and taken from a parcel

ackages which shall be not less than ten per cent. of  
t inspected, and shall be thoroughly mixed and then  
two equal samples and placed in glass vessels and  
led and a label placed on each, stating the name or  
fertilizer or material sampled, the name of the party  
stock the sample was drawn and the time and place  
and said label shall also be signed by the director or  
d by the party or parties in interest or their represent-  
at at the drawing and sealing of said sample; one of  
te samples shall be retained by the director and the  
party whose stock was sampled. All parties violat-  
shall be prosecuted by the director of said station;  
be the duty of said director, upon ascertaining any  
this act, to forthwith notify the manufacturer or im-  
ting, and give him not less than thirty days thereafter  
comply with the requirements of this act, but there  
prosecution in relation to the quality of the fertilizer  
material if the same shall be found substantially  
the statement of analysis made by the manufacturer

Sections eleven to sixteen inclusive of chapter sixty  
e Statutes are hereby repealed.

This act shall take effect on the first day of September  
eighteen hundred and eighty-eight. [*Approved May*

*issued at the Beginning of the Season, to Dealers in  
Commercial Fertilizers.*

plication for a certificate of compliance with the regu-  
e trade in commercial fertilizers and materials used  
purposes in this State must be accompanied:—

h a distinct statement of the name of each brand  
ale.

th a statement of the amount of phosphoric acid, of  
of potassium oxide, guaranteed in each distinct brand.  
h the fee charged by the State for a certificate, which  
s for each of the following articles: nitrogen, phos-  
nd potassium oxide, guaranteed in any distinct brand.  
blication to secure a certificate applies not only to  
ertilizers, but to all substances, single or compound,  
nrial purposes, and offered for sale at ten dollars or  
of two thousand pounds.

ertificate must be secured annually before the 1st of

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4. Manufacturers, importers and dealers in commercial fertilizers can appoint in this State as many agents as they desire, having secured at this office the certificate of compliance with laws.

5. Agents of manufacturers, importers and dealers in commercial fertilizers, are held personally responsible for their transactions until they can prove that the articles they offer for sale are duly recorded in this office.

6. Manufacturers and importers are requested to furnish a list of their agents.

7. All applications for certificates ought to be addressed to the director of the Massachusetts State Agricultural Experiment Station.

3. *List of Dealers who have secured Certificates for the Sale of Commercial Fertilizers in This State during the Past Year, and the Brands Licensed by the State.*

Forest City Wood Ash Company, London, Ontario, Canada : —  
Canada Unleached Wood Ashes.

Bowker Fertilizer Company, Boston, Mass : —

Stockbridge Manures.  
Bowker's Hill and Drill Phosphate  
Bowker's Ammoniated Bone Fertilizer.  
Bowker's Lawn and Garden Fertilizer.  
Bowker's Fish and Potash.  
Bowker's Dry Ground Fish.  
Gloucester Fish and Potash.  
Fine-ground Bone.  
Plain Superphosphate.  
Kainite.  
Nitrate of Soda.  
Dried Blood.  
Dissolved Bone-black.  
Muriate of Potash.  
Sulphate of Potash.

National Fertilizer Company, Bridgeport, Conn. : —

Chittenden's Complete Fertilizer  
Chittenden's Fish and Potash.  
Chittenden's Phosphate.

Hargrave Manufacturing Company, Fall River, Mass. : —

Hargrave's Bone.

William E. Fyfe & Co., Clinton, Mass. : —

Canada Unleached Wood Ashes.

Edmund Hersey, Hingham, Mass. : —

Steamed Bone.

*dealers who have secured Certificates, etc. — Continued.*

r Company, Syracuse, N. Y. : —

Brand.

d.

le Farmer's Friend Special.

or Lion Special.

New York, N. Y. : —

Coe's Gold Brand Excelsior Guano.

Potash.

rtilizer.

Bone.

Coe's High-grade Ammoniated Bone Superphosphate.

one Company, Portland, Me. : —

own Fertilizer.

nd Superphosphate.

ark Company, New York, N. Y. : —

Ammoniated Bone Superphosphate.

osphate.

Fertilizer Company, Rutland, Vt. : —

tern General for Grain and Grass.

tern Vegetable, Vine and Tobacco Fertilizer.

stern General Oats, Buckwheat and Seeding-down

ate.

n & Co., Tiverton, R. I. : —

Potash.

Special.

Standard.

l Ground Fish.

Edwards Fertilizer Company, Chicago, Ill. : —

Good Tobacco Guano.

& Co., Boston, Mass. : —

Bay State Bone Superphosphate.

Bone Superphosphate.

son, Lancaster, Mass. : —

Complete Animal Fertilizer.

Manufacturing Company, New York, N. Y. : —

ounty.

Complete Manures.

Potash.

izer Company, New York, N. Y. : —

Potato Manure.

Vegetator.

Special Favorite.

ltural Chemical Works, Newark, N. J. : —

andard Superphosphate of Lime.

mmuniated Dissolved Bone.

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### 3. *List of Dealers who have secured Certificates, etc.* — Con

J. M. Butman, Lowell, Mass. : —

Lowell Bone Fertilizer.

Adams & Thomas, Springfield, Mass. : —

Adams Market Bone Fertilizer.

Whittemore Brothers, Wayland, Mass. : —

Whittemore's Complete Manure.

Mayo & Hix, Boston, Mass. : —

Mayo Superphosphate.

John C. Dow & Co., Boston, Mass. : —

Dow's Ground Bone Fertilizer.

J. E. Soper & Co, Boston, Mass. : —

Cotton-seed Hull Ashes.

F. C. Sturtevant, Hartford, Conn. : —

Tobacco Stems.

E. H. Smith, Northborough, Mass. : —

Smith's Steamed Bone.

A. L. Ames, Peabody, Mass. : —

Ames' Bone Fertilizer.

The Mapes Formula and Peruvian Guano Company, New York, N

The Mapes Bone Manures.

Peruvian Guanos.

The Mapes Superphosphate.

The Mapes Special Corn Manures.

C. A. Bartlett, Worcester, Mass. : —

C. A. Bartlett's Pure Ground Bone.

Animal Fertilizer.

Bradley Fertilizer Company, Boston, Mass. : —

Bradley's XL Phosphate.

B. D. Sea-fowl Guano.

Coe's Superphosphate.

Fish and Potash.

Pure Fine-ground Bone.

Bradley's Complete Manures : —

For Potatoes and Vegetables.

For Corn and Grain.

For Top-dressing Grass and Grain.

Bradley's Grass Manure for Top-dressing.

Bradley's Potato Manure.

Nitrate of Soda.

Sulphate of Ammonia.

Muriate of Potash.

Dissolved Bone-black.

Cleveland Dryer Company, Cleveland, Ohio : —

Cleveland Potato Phosphate.

Cleveland Superphosphate.

*Dealers who have secured Certificates, etc. — Continued.*

Manufacturing Company, Boston, Mass. : —  
 en Fertilizer.

, New Worcester, Mass. : —  
 und Bone.

ntman & Co., Tiverton, R. I. : —  
 Potash.  
 phosphate.  
 und Fish.

rockton, Mass. : —  
 r's Pure Ground Bone.

lizer and Chemical Company, Buffalo, N. Y. : —  
 al Ammoniated Superphosphate.  
 Superphosphate, No. 2.  
 Potato Manure.  
 ound Bone.

ated Bone Superphosphate.  
 lop and Tobacco Phosphate.  
 ility Phosphate.  
 e Bone Superphosphate.  
 ated Wheat and Corn Phosphate.

ilizer Company, Boston, Mass. : —  
 Superphosphate.  
 Lawn and Garden Dressing.

on & Stroup, Oswego, N. Y. : —  
 d Canada Wood Ashes.

, Boston, Mass. : —  
 Market-garden Fertilizer.  
 Combined Bone.

Company, Boston, Mass. : —  
 Star Brand 203 Fertilizer.  
 Star Brand Special Potato Fertilizer.

Company, Boston, Mass. : —  
 Pacific Guano.  
 Potash.  
 Potato Manure.

ac Company, New London, Conn. : —  
 ac Phosphate.  
 ac Potato Manure.  
 ac Dry Ground Fish.  
 ac Fish and Potash.

Boston, Mass. : —  
 e Fertilizer.  
 Bone.

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3. *List of Dealers who have secured Certificates, etc.* — Concl

H. J. Baker &amp; Bros., New York, N. Y. : —

A. A. Ammoniated Superphosphate.

Pelican Bone Fertilizer.

Potato Manure.

John G. Jefferds, Worcester, Mass. : —

Jefferds' Animal Fertilizer.

Jefferds' Fine-ground Bone.

N. Ward Company, Boston, Mass. : —

N. Ward Company's High-grade Animal Fertilizer.

L. B. Darling Fertilizer Company, Pawtucket, R. I. : —

Darling's Animal Fertilizer.

Extra Bone Phosphate.

Darling's Potato and Root Crop Manure.

Darling's Pure Bone.

Muriate of Potash.

Sulphate of Potash.

Butler, Breed &amp; Co., Boston, Mass. : —

Economic No. 1 Fertilizer for Grass.

Economic No. 2 Fertilizer for Pasture.

Economic No. 3 Fertilizer for Corn.

Economic No. 4 Fertilizer for Potatoes.

Economic No. 7 Fertilizer for Garden.

Stearns' Fertilizer Company, New York, N. Y. : —

Stearns' Ammoniated Bone Superphosphate.

Stearns' American Guano.

Thos. Hersom &amp; Co., New Bedford, Mass. : —

Pure Fine-ground Bone.

H. L. Phelps, Southampton, Mass. : —

H. L. Phelps' Complete Manure.

Prentiss, Brooks &amp; Co., Holyoke, Mass. : —

Dry Fish.

Dissolved Bone-black.

Muriate of Potash.

Nitrate of Soda.

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at—
<i>Compound Fertilizers.</i>			
7	High-grade Farmer's Friend Special,	Read Fertilizer Company, New York,	Pittsfield.
8	Karmer's Friend,	Read Fertilizer Company, New York,	Pittsfield.
9	Lion Brand,	Read Fertilizer Company, New York,	Pittsfield.
11	Quinapiac Phosphate,	The Quinapiac Company, New London, Conn.,	No. Amherst.
12	Quinapiac Fish and Potash,	The Quinapiac Company, New London, Conn.,	No. Amherst.
13	Quinapiac Potato Manure,	The Quinapiac Company, New London, Conn.,	No. Amherst.
17	Vegetator,	Davidge Fertilizer Company, New York,	Amherst.
18	Bowler's Potato Grover,	Bowler Fertilizer Company, Boston,	Sunderland.
22	Chittenden's Universal Phosphate,	National Fertilizer Company, Bridgeport, Conn.,	Sunderland.
24	Chittenden's Tobacco Fertilizer,	National Fertilizer Company, Bridgeport, Conn.,	Sunderland.
33	Mapes' Potato Manure,	Mapes Formula and Peruvian Guano Company, New York,	Worcester.
<i>Bones and Tankage.</i>			
2	Hargrave's Bone,	Hargrave Manufacturing Company, Fall River, Mass.,	Fall River.
3	Steamed Bone,	Edmund Hervey, Hingham, Mass.,	Hingham.
4	Steamed Bone,	Edward H. Smith, Northborough, Mass.,	Amherst.
38	Holmes' Steamed Bone,	G. E. Holmes, Worcester, Mass.,	Worcester.
43	Bartlett's Steamed Bone,	C. A. Bartlett, Worcester, Mass.,	Worcester.

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Labo- ratory Number	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
5	Lowell Bone Fertilizer.	J. M. Butman, Lowell, Mass.,	Lowell.
10	Sampson Brand or Lion Special.	Read Fertilizer Company, New York.	Pittsfield.
15	Special Favorite.	Davidge Fertilizer Company, New York.	Amherst.
19	Stockbridge's Tobacco Manure.	Bowler Fertilizer Company, Boston, Mass.,	Sunderland.
25	Cumberland Bone Superphosphate.	Cumberland Bone Company, Portland, Me.,	Sunderland.
32	Mapes' Complete Manure.	Mapes Formula and Peruvian Guano Company, New York.	Worcester.
39	Bradley's X.L. Superphosphate of Lime.	Bradley Fertilizer Company, Boston, Mass.,	Worcester.
42	Jeffers' Animal Fertilizer with Potash.	J. G. Jeffers, Worcester, Mass.,	Worcester.
44	Americus Brand Ammoniated Superphosphate.	Williams & Clark Company, New York.	Worcester.
54	Church's Fish and Potash.	Joseph Church & Co., Tiverton, R.I.,	Springfield.
55	Adams' Market Bone Fertilizer.	Adams & Thomas, Springfield, Mass.,	Springfield.
57	Dry Fish Guano.	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
58	Bradley's Fish and Potash, "A" Brand.	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
68	Original Bay State Bone Superphosphate.	J. A. Tucker & Co., Boston, Mass.,	Chelsea.
69	Imperial Bone Superphosphate.	J. A. Tucker & Co., Boston, Mass.,	Chelsea.
83	Ames' Bone Fertilizer.	A. L. Ames, Featbody, Mass.,	Chelsea.
84	Dow's Nitrogenous Superphosphate.	J. C. Dow & Co., Boston, Mass.,	Chelsea.
88	Darling's Pure Dissolved Bone.	Darling Fertilizer Company, Pawtucket, R. I.,	Chelsea.
111	Extra Bone Phosphate.	Darling Fertilizer Company, Pawtucket, R. I.,	Chelsea.
30	Cotton-hull Ashes.	Quinaplace Company, New London, Conn.,	Chelsea.
29	Muriate of Potash.	Quinaplace Company, New London, Conn.,	Chelsea.

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<i>Compound Fertilizers.</i>					
16	Potato Fertilizer, . . . . .	Davidge Fertilizer Company, New York, . .	Amherst.		
20	Animal Fertilizer, . . . . .	Bowler Fertilizer Company, Boston, Mass., .	Sunderland.		
49	Ammoniated Bone Superphosphate, American Brand, . .	Williams & Clark Co., New York, . . . .	Springfield.		
52	A. A. Ammoniated Bone Superphosphate, . . . . .	H. J. Baker & Bro., New York, . . . . .	Springfield.		
108	A. A. Ammoniated Bone Superphosphate, . . . . .	H. J. Baker & Bro., New York, . . . . .	New Bedford.		
53	Potato Manure, . . . . .	H. J. Baker & Bro., New York, . . . . .	Springfield.		
59	Chittenden's Complete Fertilizer for Grass, . . . . .	National Fertilizer Company, Bridgeport, Conn., .	Northampton.		
61	Mages' Complete Manure for Light and Sandy Soils, . .	Mages Formula and Peruvian Guano Company, New York, .	Northampton.		
65	Red Brand, Special Fertilizer for Potatoes, Cabbage and Pease, .	Le Page Company, Boston, Mass., . . . . .	Boston.		
76	Randall Market Garden Fertilizer, . . . . .	Benj. Randall, Boston, Mass., . . . . .	Boston.		
98	Crocker's New Rival Ammoniated Superphosphate, . .	Crocker Fertilizer and Chemical Company, Buffalo, N. Y., .	Haverhill.		
102	Lawrence Fertilizer, . . . . .	Lee, Blackburn & Co., Lawrence, Mass., . .	Lawrence.		
110	Potato and Root Crop Manure, . . . . .	L. B. Darling Fertilizer Company, Pawtucket, R. I., .	Taunton.		
124	Jennison's Animal Fertilizer, . . . . .	Edward F. Jennison, Lancaster, Mass., . . . .	South Lincoln.		
129	Lister's Ammoniated Dissolved Bone, . . . . .	Lister's Agricultural Chemical Works, Newark, N. J., .	Turner's Falls.		
132	Sea-fowl Guano, . . . . .	Bradley Fertilizer Company, Boston, Mass., .	Turner's Falls.		
134	Orient Complete Manure, . . . . .	Orient Guano Company, Orient, L. I., . . . .	Sheffield.		
135	Great Eastern Tobacco Fertilizer, . . . . .	Great Eastern Fertilizer Company, Rutland, Vt., .	Pittsfield.		
137	Potato Fertilizer, . . . . .	E. Frank Coe, New York, . . . . .	Westfield.		
<i>Bones and Tankage.</i>					
123	Hersom's Tankage, . . . . .	Thomas Hersom & Co., New Bedford, . . . .	New Bedford.		
96	Bowler's Fine-ground Bone, . . . . .	Bowler Fertilizer Company, Boston, Mass., .	Haverhill.		
118	Hargrave's Fine-ground Bone, . . . . .	Hargrave Manufacturing Company, Fall River, .	Fall River.		

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## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.						AVAILABLE.		POTASSIUM OXIDE IN ONE HUNDRED POUNDS.																					
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	TOTAL.		Found.	Guaranteed.	Found.	Guaranteed.																					
								Found.	Guaranteed.																									
<i>Compound Fertilizers.</i>																																		
16	Potato Fertilizer, . . . . .	12.37	3.08	2.88-3.71	8.10	1.06	1.32	10.18	10-12	9.16	9.5-11	3.02		*																				
20	Animal Fertilizer, . . . . .	9.93	2.97	—	6.14	1.06	6.40	14.50	10-12	8.10	6-8	3.34		†																				
49	Ammon. Bone Superphos., American Brand,	16.86	2.66	2-3	9.03	1.65	0.23	10.91	30-16	10.68	10-12	1.98		2-3																				
52	A. A. Ammoniated Superphosphate, . . .	13.32	3.42	2.47-3.3	10.09	1.36	1.13	12.58	—	11.45	10-12	2.58		2-3																				
53	Potato Manure, . . . . .	9.89	4.17	3.30	5.95	1.34	0.81	8.70	—	7.29	5.75	9.33		10.																				
59	Chittenden's Complete Fertilizer for Grass,	12.86	3.62	4.12-4.94	5.88	3.43	2.91	12.22	6-8	9.31	4-6	5.66		5-7																				
61	Mapes' Com. Manure for Light and Sandy Soil,	11.40	5.66	4.94-6.59	5.50	1.19	2.30	8.99	8-10	6.69	8.	6.46		6-8																				
65	Red Star Brand, Spec. Fert. for Potatoes, etc.,	15.37	3.01	3-4	4.16	2.35	3.26	9.77	8-10	6.51	6-8	3.34		*																				
76	Randall's Market Garden Fertilizer, . . .	11.32	3.26	2.88-3.71	5.28	2.51	1.68	9.45	—	7.70	8.5-11	2.68		4-5																				
85	Crocker's New Rival Ammo. Superphosphate,	13.52	1.43	1.23-2.06	7.94	1.72	1.33	11.05	—	9.06	10-12	2.08		*																				
102	Lawrence Fertilizer, . . . . .	15.37	1.78	2.00-2.88	9.86	1.34	0.95	12.15	10-12	11.29	—	1.61		2-3																				
110	Potato and Root Crop Manure, . . . . .	12.57	3.12	2.88-4.12	4.81	1.91	3.81	10.53	10-12	6.72	—	8.96		7-9																				
124	Levenson's Animal Fertilizer, . . . . .	5.39	6.40	3-4	0.08	5.60	6.78	12.70	11-12.5	6.01	6-8	8.94		7-8																				
129	Usher's Ammoniated Dissolved Bone, . .	14.84	2.69	1.65-2.06	7.14	2.07	3.39	12.60	10-15	9.21	8-10	1.67		1-2																				
132	Sea-fowl Guano, . . . . .	13.61	2.60	2.00-2.68	7.38	2.84	3.19	13.41	11-14	10.22	9-11	2.42		2-3																				
134	Orient Complete Manure, . . . . .	13.84	2.20	1.60-2.47	8.71	0.18	1.41	10.30	—	8.80	8-12	2.28		2-4																				
135	Great Eastern Tobacco Fertilizer, . . .	14.12	2.31	1.65-2.47	7.54	1.58	1.66	10.68	—	9.12	8-12	4.51		6-8																				
137	Potato Fertilizer, . . . . .	13.21	2.06	2-2.5	7.48	1.33	1.66	10.67	—	9.01	8-11	5.52		*																				
<i>MECHANICAL ANALYSES.</i>																																		
<table><tr><th></th><th>Fine.</th><th>Medium.</th><th>Medium.</th><th>Coarse.</th></tr><tr><td>Hersom's Tankage, . . . . .</td><td>50.80</td><td>28.77</td><td>11.18</td><td>9.25</td></tr><tr><td>Bowker's Fine-ground Bone, . . . . .</td><td>40.43</td><td>25.01</td><td>14.29</td><td>10.36</td></tr><tr><td>Hargrave's Fine-ground Bone, . . . . .</td><td>40.43</td><td>25.01</td><td>14.29</td><td>10.36</td></tr></table>																Fine.	Medium.	Medium.	Coarse.	Hersom's Tankage, . . . . .	50.80	28.77	11.18	9.25	Bowker's Fine-ground Bone, . . . . .	40.43	25.01	14.29	10.36	Hargrave's Fine-ground Bone, . . . . .	40.43	25.01	14.29	10.36
	Fine.	Medium.	Medium.	Coarse.																														
Hersom's Tankage, . . . . .	50.80	28.77	11.18	9.25																														
Bowker's Fine-ground Bone, . . . . .	40.43	25.01	14.29	10.36																														
Hargrave's Fine-ground Bone, . . . . .	40.43	25.01	14.29	10.36																														

\* Sulphate of potash the source of potash.

† Guaranteed as contents of potash.

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at—
	<i>Compound Fertilizers.</i>		
1	Ames' Bone Fertilizer, . . . . .	A. L. Ames, Peabody, Mass., . . . . .	Peabody.
28	Stockbridge's Manure for Top Dressing, . . . . .	Bowker Fertilizer Company, Boston, Mass., . . . . .	Springfield.
46	Chittenden's Ammoniated Bone Superphosphate, . . . . .	National Fertilizer Company, Bridgeport, Conn., . . . . .	Fitchburg.
71	Standard Superphosphate, . . . . .	Standard Fertilizer Company, Duxbury, Mass., . . . . .	Boston.
78	Economic No. 1, for Grass, . . . . .	Economic Fertilizer Company, Boston, Mass., . . . . .	Boston.
105	Church's Dry Ground Fish, . . . . .	Joseph Church & Co., Tiverton, R. I., . . . . .	New Bedford.
127	Cumberland Superphosphate, . . . . .	Cumberland Bone Company, Portland, Me., . . . . .	Worcester.
144	Cumberland Seeding-down Fertilizer, . . . . .	The American Manufacturing Company, Boston, Mass., . . . . .	Dighton.
145	The Allen Fertilizer, . . . . .	Mayo & Hix, Boston, Mass., . . . . .	Woburn.
146	Mayo's Superphosphate, . . . . .	Davidge Fertilizer Company, New York, . . . . .	Waltham.
147	Davidge's Potato Manure, . . . . .	Davidge Fertilizer Company, New York, . . . . .	Belchertown.
148	Special Favorite, . . . . .	Quinnipiac Company, Agents, New London, Conn., . . . . .	Belchertown.
14	Sulphate of Potash, . . . . .		North Amherst.
	<i>Bones.</i>		
41	Jefferts' Steamed Bone, . . . . .	J. G. Jefferts, Worcester, Mass., . . . . .	Worcester.
73	Standard Pure Ground Bone, . . . . .	Standard Fertilizer Company, Duxbury, Mass., . . . . .	Boston.
87	Darling's Pure Ground Bone, . . . . .	Darling Fertilizer Company, Pawtucket, R. I., . . . . .	Ipswich.
103	Lawrence Bone Meal, . . . . .	Lee & Co., Lawrence, Mass., . . . . .	Lawrence.
143	S. Winter's Pure Ground Bone, . . . . .	S. Winter, Brockton, Mass., . . . . .	Brockton.

PABOT SCIENCE LIBRARY



Number of Laboratory	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at.
21	Stockbridge's Vegetable and Potato Manure,	Bowker Fertilizer Company, Boston, Mass.,	Sunderland.
22	Ammoniated Bone Fertilizer,	Bowker Fertilizer Company, Boston, Mass.,	Sunderland.
31	Dry Ground Fish,	Quinnipiac Company, New London, Conn.,	Northampton.
34	Mapes' Complete Manure, "A" Brand,	Mapes Formula and Peruvian Guano Company, New York,	Worcester.
45	Potato Phosphate,	Williams & Clark Company, New York,	Worcester.
50	Potato Phosphate,	Williams & Clark Company, New York,	Springfield.
51	Bradley's Potato Manure,	Bradley Fertilizer Company, Boston, Mass.,	Springfield.
66	Bradley's Fish and Potash, Anchor Brand,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
64	203 Fertilizer for General Crops,	Le Page Company, Boston, Mass.,	Boston.
70	Breck's Lawn and Garden Dressing,	Standard Fertilizer Company, Duxbury, Mass.,	Boston.
77	Randall's Bone and Potash,	Benj. Randall, Boston, Mass.,	Boston.
86	Cleveland Superphosphate,	Cleveland Driver Company, Cleveland, Ohio,	Ipswich.
92	Bowker's Hill and Drill Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Haverhill.
97	Crocker's Vegetable Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Haverhill.
99	Crocker's Ammoniated Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Chelmsford.
104	Lowell Bone Fertilizer,	J. M. Bairman, Chelmsford, Mass.,	Fall River.
114	Soluble Pacific Guano,	Glidden & Curtis, Boston, Mass.,	Fall River.
115	Brightman's Dry Ground Menhaden Fish Guano,	W. J. Brightman & Co., Tiverton, R. I.,	Fall River.
116	Brightman's Ammoniated Bone Superphosphate,	W. J. Brightman & Co., Tiverton, R. I.,	Fall River.
119	Darling's Animal Fertilizer,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Hatfield.
125	Americo Guano, the Standard Potato Manure,	Stearns Fertilizer Company, New York,	Worcester.
133	High-grade Ammoniated Bone Superphosphate,	E. Frank Coe, New York,	No. Adams.

CASEY SCIENCE LIBRARY



Laboratory Number	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at—
27	Lawn and Garden Dressing,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
35	Mapes' Corn Manure,	Mapes Formula and Peruvian Guano Company, New York,	Worcester.
47	Chittenden's Complete Fertilizer,	National Fertilizer Company, Bridgeport, Conn.,	Fitchburg.
48	Flamingo Guano,	Liebig & Gibbons, Baltimore, Md.,	Fitchburg.
63	Mapes' Tobacco Manure, Conn. Brand,	Mapes Formula and Peruvian Guano Company, New York,	Northampton.
66	Red Star Brand Special Fertilizer for Onions and Tobacco,	LePage Company, Boston, Mass.,	Boston.
67	Red Star Brand, The Perfect Lawn Dressing,	LePage Company, Boston, Mass.,	Boston.
72	Breck's Top Dressing,	Standard Fertilizer Company, Duxbury, Mass.,	Boston.
81	Economic No. 4, for Potatoes,	Economic Fertilizer Company, Boston, Mass.,	Boston.
85	Cleveland Potato Phosphate,	Cleveland Dryer Company, Cleveland, O.,	Ipawich.
91	Stockbridge's Manure for Seeding-down,	Bowker Fertilizer Company, Boston, Mass.,	Haverhill.
96	Bradley's XL Superphosphate of Lime,	Bradley Fertilizer Company, Boston, Mass.,	Haverhill.
100	Crocker's Potato, Hop and Tobacco Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Haverhill.
101	Crocker's Ammoniated Bone,	Glidden & Curtis, Boston, Mass.,	Plymouth.
113	Pacific Guano Company's Special Potato Manure,	W. J. Brightman & Co., Iyerton, R. I.,	Fall River.
117	Brightman's Fish and Potash,	Thompson & Edwards Fertilizer Company, Chicago, Ill.,	Hatfield.
120	World of Good Potato Grower,	Stearns Fertilizer Company, New York,	Worcester.
126	Stearns' High-grade Ammoniated Bone Superphosphate,	Great Eastern Fertilizer Company, Rutland, Vt.,	Pittsfield.
136	Great Eastern Grain and Grass Fertilizer,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
138	H. L. Phelps' Phosphate,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
139	H. L. Phelps' Potato Manure,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
140	H. L. Phelps' Complete Manure for Corn and Grass,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.

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## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.				POTASSIUM OXIDE IN ONE HUNDRED POUNDS.			
		Molature.	Guaranteed.	Soluble.	Reverted.	Insoluble.	TOTAL.		Round.	Guaran- teed.	Round.
							Round.	Guaran- teed.			
27	Lawn and Garden Dressing, . . . . .	11.17	3.28	3.30-4.12	9.92	1.66	14.27	-	11.58	5-6	3.60
35	Mapes' Corn Manure, . . . . .	12.73	4.12	3.71-4.12	5.12	3.81	12.13	10-12	8.93	-	6.29
47	Chittenden's Complete Fertilizer, . . . . .	12.01	2.98	3.30-4.12	4.10	6.56	13.96	8-10	10.86	6-8	6.11
48	Flamingo Guano, . . . . .	12.35	0.80	.62-1.03	0	13.25	19.52	13-19	13.25	10-14	0.70
63	Mapes' Tobacco Manure, Conn. Brand, . . . . .	4.52	4.48	4.74	4.67	3.65	12.54	7.75	8.32	-	5.89
66	Red Star Brand, Special Fertilizer for Onions and Tobacco, . . . . .	15.46	3.32	2.47-3.30	3.74	2.46	10.33	6-8	6.20	-	4.02
67	Red Star Brand, The Perfect Lawn Dressing, . . . . .	6.82	3.88	4-6	6.45	1.20	10.80	10-12	7.65	8-10	4.12
72	Breck's Top Dressing, . . . . .	8.40	5.96	5.77-6.59	4.80	2.04	7.10	6-8	6.84	6-6	2.60
81	Economic No. 4, for Potatoes, . . . . .	11.74	0.93	.25-.75	0	0	6.41	2-4.5	0	-	Trace.
85	Cleveland Potato Phosphate, . . . . .	8.15	4.36	2.06-2.88	6.73	2.47	12.73	10-13	9.20	8-10	3.26
91	Stockbridge's Manure for Seeding-down, . . . . .	10.93	2.81	2.47-3.30	5.68	2.21	13.87	12-14	7.89	6-8	2.94
96	Bradley's XL Superphosphate of Lime, . . . . .	15.82	2.74	2.50-3.25	8.82	1.62	12.34	11-14	10.44	9-11	1.86
100	Crocker's Potato, Hop and Tobacco Phosphate, . . . . .	13.50	3.23	2-3	8.70	1.72	11.16	9-14	10.42	8-12	3.46
101	Crocker's Ammoniated Bone, . . . . .	12.10	3.96	2.88-3.71	6.74	2.87	10.88	11-14	9.61	10-12	1.27
113	Pacific Guano Co.'s Special Potato Manure, . . . . .	13.22	3.66	3.30-4.12	5.63	2.40	9.75	8-12	7.93	6-8	5.5-7
117	Brightman's Fish and Potash, . . . . .	26.80	3.88	2.47-4.12	0.80	7.47	2.89	-	8.27	-	2.67
120	World of Good Potato Grower, . . . . .	8.44	2.14	2.47-3.30	3.04	5.44	13.72	-	8.43	6-8	3.06
126	Stearns' High-grade Am. Bone Superphosphate, . . . . .	12.60	2.68	2.26-2.88	2.84	3.10	12.20	10.5-14	8.94	8.5-11	3.12
136	Great Eastern Grain and Grass Fertilizer, . . . . .	19.47	2.56	2.88-3.71	6.52	1.73	11.45	9-15	8.25	8-12	2.67
138	H. L. Phelps' Phosphate, . . . . .	13.35	2.92	2.47-3.30	12.72	0.24	13.20	8-10	12.06	-	3.71
139	H. L. Phelps' Potato Manure, . . . . .	8.59	4.13	4.12-4.94	5.45	3.83	10.91	8-10	9.28	5-7	9.45
140	H. L. Phelps' Complete Manure, Corn and Grass, . . . . .	8.12	4.12	4.12-4.94	5.69	2.72	9.66	8-10	8.41	8-10	9.86

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at—
36	Stockbridge's Manure for Onions,	Bowker Fertilizer Company, Boston, Mass.,	Worcester.
40	Lawn Fertilizer, Tobacco and Sulphur,	F. C. Sturtevant, Hartford, Conn.,	Worcester.
60	Chittenden's Complete Fertilizer for Potatoes,	National Fertilizer Company, Bridgeport, Conn.,	Northampton.
74	Peruvian Guano,	Mapes Formula and Peruvian Guano Company, New York,	Boston.
75	Animal Fertilizer for Lawn and Garden,	Darling Fertilizer Company, Pawtucket, R. I.,	Boston.
80	Economic No. 3, for Corn,	Economic Fertilizer Company, Boston, Mass.,	Boston.
89	The Economic Fertilizer for All Crops,	Baugh & Sons, Philadelphia and Baltimore,	Newburyport.
93	Stockbridge's Manure for Strawberries,	Bowker Fertilizer Company, Boston, Mass.,	Haverhill.
94	Stockbridge's Manure for Grapes, Raspberries, etc.,	Bowker Fertilizer Company, Boston, Mass.,	Haverhill.
107	Baker's Special Corn Manure,	H. J. Baker & Bro., New York, N. Y.,	New Bedford.
109	Special Grass Manure,	H. J. Baker & Bro., New York, N. Y.,	New Bedford.
112	N. Ward & Co.'s High-grade Animal Fertilizer,	N. Ward & Co., Boston, Mass.,	Boston.
121	World of Good Raw Bone Superphosphate,	Thompson & Edwards Fertilizer Company, Chicago, Ill.,	Hatfield.
130	Lister's Celebrated Onion Fertilizer,	Lister's Agricultural Chemical Works, Newark, N. J.,	Turner's Falls.
141	Fish and Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
142	Lawn Dressing,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
149	Whittemore Bros.' Bone Fertilizer,	Whittemore Bros., Wayland, Mass.,	Wayland.
26	Cotton-hull Ashes,	H. L. Phelps, Southampton, Mass., Agent,	Sunderland.
37	Nitrate of Soda,	Bowker Fertilizer Company, Boston, Mass.,	Worcester.

CABOT SCIENCE LIBRARY





*Analysis of Commercial Fertilizers and Manurial  
Substances sent on for Examination.*

*Wood Ashes.*

I. sent on from Amherst, Mass.; IV. sent on by E. C. Smith,  
Rowley, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
° C, . . . . .	6.49	9.30	0.44	7.03
. . . . .	38.36	38.58	24.62	32.31
de, . . . . .	2.74	2.72	4.70	4.03
. . . . .	2.29	1.89	—	—
e, . . . . .	4.53	4.84	5.69	4.36
d, . . . . .	2.48	2.99	4.61	2.38
er (before calcination),	17.54	18.08	41.92	19.53
er (after calcination), .	14.51	15.36	37.22	13.99

*Wood Ashes.*

by C. H. Thompson & Co., Boston, Mass.; III. sent on by J. C.  
Amherst, Mass.; IV. sent on by Chas. N. Perley, Danvers, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
° C., . . . . .	8.03	0.55	6.98	7.72
. . . . .	22.69	33.58	37.28	42.39
de, . . . . .	6.15	3.74	5.13	2.65
e, . . . . .	6.52	1.91	5.56	5.38
d, . . . . .	1.66	1.32	2.30	1.15
er (before calcination),	27.92	3.64	13.91	9.26
er (after calcination), .	23.75	2.03	11.50	6.37

CARNEGIE SCIENCE LIBRARY

## 260 AGRICULTURAL EXPERIMENT STATION.

5. *Analyses, etc.* — Continued.*Wood Ashes.*

[I. and II. sent on by Frank Wheeler, Concord, Mass.; III. and IV. sent  
E. W. McGarvey, London, Ont.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	16.55	15.58	7.53
Calcium oxide, . . . . .	36.59	34.20	39.61
Magnesium oxide, . . . . .	3.01	2.86	2.42
Potassium oxide, . . . . .	4.29	4.82	6.39
Phosphoric acid, . . . . .	2.44	1.76	1.28
Insoluble matter (before calcination),	15.15	20.75	11.14
Insoluble matter (after calcination), .	12.42	18.35	8.32

*Wood Ashes.*

[Sent on by Frank Goodwin, Framingham, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	20.33	15.54	.10
Calcium oxide, . . . . .	31.21	32.77	40.01
Magnesium oxide, . . . . .	3.51	3.21	3.73
Potassium oxide, . . . . .	3.57	3.75	9.80
Phosphoric acid, . . . . .	2.90	1.45	2.16
Insoluble matter (before calcination),	13.31	12.56	15.54
Insoluble matter (after calcination), .	10.51	10.06	11.94

5. *Analyses, etc.* — Continued.*Wood Ashes.*

Frank Goodwin, Framingham, Mass.; II. sent on by Chas. W. Jenks,  
; III. sent on by Frank E. Kimball, Danvers, Mass.; IV. sent on  
y, Danvers, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
° C., . . . . .	.15	20.40	15.64	14.46
. . . . .	44.59	30.98	31.56	32.14
ide, . . . . .	7.24	3.14	3.27	2.59
le, . . . . .	4.27	4.26	4.12	4.36
d, . . . . .	3.73	1.54	1.28	2.71
er (before calcination),	11.70	13.53	24.10	16.48
er (after calcination), .	10.42	10.49	13.50	13.26

*Wood Ashes.*

Amherst, Mass.; II. sent on by Urbane Derby, Concord, Mass.;  
W. E. Allen, Lancaster, Mass.; IV. sent on by E. F. Manchester,  
ss.]

	PER CENT.			
	I.	II.	III.	IV.
° C., . . . . .	19.30	7.08	.25	4.77
. . . . .	30.54	39.54	27.48	32.52
ide, . . . . .	2.75	4.64	4.41	4.60
le, . . . . .	5.16	3.60	5.07	4.23
d, . . . . .	1.77	1.95	2.28	2.07
er (before calcination),	14.50	14.74	39.10	24.76
er (after calcination), .	10.20	12.53	37.75	20.04

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5. *Analyses, etc.* — Continued.*Wood Ashes.*

[I. and II. sent on by J. A. Merriam, Framingham, Mass.; III. sent on by R. South Framingham, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	19.04	21.47
Calcium oxide, . . . . .	36.35	32.66
Magnesium oxide, . . . . .	2.82	2.36
Potassium oxide, . . . . .	4.63	3.26
Phosphoric acid, . . . . .	1.65	1.70
Insoluble matter (before calcination), .	8.07	8.25
Insoluble matter (after calcination), .	7.15	7.86

*Wood Ashes.*

[I. sent on by W. H. Davis, Littleton, Mass.; II. and III. sent on by A. H. Harvard, Mass.; IV. sent on by Flagg & Russell, Warningsville, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	2.42	15.72	13.88
Calcium oxide, . . . . .	36.94	28.61	34.03
Magnesium oxide, . . . . .	3.24	3.00	3.07
Ferric oxide, . . . . .	2.74	1.03	.49
Potassium oxide, . . . . .	7.82	8.72	5.59
Phosphoric acid, . . . . .	.51	.32	.54
Insoluble matter (before calcination),	16.43	18.49	13.51
Insoluble matter (after calcination), .	12.18	12.12	11.33

5. *Analyses, etc.* — Continued.*Wood Ashes.*

by Coolidge Bros., South Sudbury, Mass ; III. and IV. sent on  
by James Logan, Worcester, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
00° C, . . . . .	15.73	11.86	24.96	15.97
e, . . . . .	37.18	43.13	15.83	39.76
xide, . . . . .	3.56	1.80	2.14	1.82
de, . . . . .	5.22	3.66	3.74	2.40
id, . . . . .	1.57	3.84	1.89	6.10
ter (before calcination),	6.44	7.06	16.20	8.39
ter (after calcination), .	5.61	6.41	12.50	5.93

*Cotton-seed Hull Ashes.*

lyman A. Crafts, Whately, Mass.; II. sent on by S. G. Hubbard,  
s.; III. sent on by A. W. Field, North Hadley, Mass.; IV. sent on  
Sunderland, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
00° C., . . . . .	10.24	9.97	.86	11.96
e, . . . . .	8.89	9.59	9.80	4.41
xide, . . . . .	12.61	13.58	16.05	12.29
. . . . .	1.14	1.54	1.92	—
de (6 cents per pound), .	28.44	25.17	22.58	29.36
id (6 cents per pound), .	10.28	9.16	8.02	12.99
ter (before calcination),	—	—	10.73	7.38
ter (after calcination), .	6.11	.96	6.50	3.68
ton, . . . . .	\$46.46	\$41.20	\$36.72	\$50.82

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5. *Analyses, etc.* — Continued.*Cotton-seed Hull Ashes.*

[I. and II. sent on by S. G. Hubbard, Hatfield, Mass.]

	PER CENT.	
	I.	
Moisture at 100° C., . . . . .	8.13	
Calcium oxide, . . . . .	7.26	
Magnesium oxide, . . . . .	10.99	
Ferric oxide, . . . . .	1.25	
Potassium oxide (6 cents per pound), . . . . .	25.35	
Phosphoric acid (6 cents per pound), . . . . .	10.68	
Insoluble matter (before calcination), . . . . .	13.59	
Insoluble matter (after calcination), . . . . .	11.61	
Valuation per ton, . . . . .	\$43 24	\$3

*Sulphate of Potash.*

[I. sent on from Amherst, Mass.; II. and III. sent on from Feeding Hills, Mass.]

	PER CENT.		
	I.	II.	
Moisture at 100° C., . . . . .	4.87	7.54	8
Potassium oxide (6 cents per pound), . . . . .	37.54	25.81	17
Sulphuric acid, . . . . .	45.96	46.96	50
Insoluble matter, . . . . .	.94	—	
Valuation per ton, . . . . .	\$45 05	\$30 97	\$2

5. *Analyses, etc.* — Continued.*Muriate of Potash.*

[Sent on from Amherst, Mass.]

	PER CENT.		
	I.	II.	III.
0° C., . . . . .	4.01	2.22	2.41
. . . . .	2.88	12.44	11.50
de ( $4\frac{1}{2}$ cents per pound), .	45.16	47.30	49.86
. . . . .	45.67	52.00	52.00
ter, . . . . .	1.01	Trace.	Trace
ton, . . . . .	\$40 64	\$42 57	\$44 87

*Gypsum.*

from Wellesley Hills, Mass.; II. sent on from Amherst, Mass.]

	PER CENT.	
	I.	II.
0° C., . . . . .	38.47	14.05
, . . . . .	16.21	32.65
, . . . . .	21.43	41.90
ter, . . . . .	11.30	2.22

No. I. is a factory refuse article.

*Lime.*

[Sent on from Amherst, Mass.]

	Per Cent.
, . . . . .	74.79
ter, . . . . .	.77

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5. *Analyses, etc.* — Continued.*South Carolina Phosphate.*

[Sent on from Amherst, Mass. I., finely ground "Floats;" II., Apatite.]

	Per Cent.	
	I.	II.
Moisture at 100° C., . . . . .	.39	
Calcium oxide, . . . . .	46.76	
Ferric and aluminic oxides, . . . . .	5.78	
Total phosphoric acid, . . . . .	27.57	
Soluble phosphoric acid, . . . . .	0.00	
Reverted phosphoric acid (7½ cents per pound), . . . .	4.27	
Insoluble phosphoric acid (2 cents per pound), . . . .	23.30	
Insoluble matter, . . . . .	9.04	
Valuation per ton, . . . . .	\$15 73	

*Mona Island Guano.*

[Sent on by J. Campbell &amp; Co., New York, N. Y.]

Moisture at 100° C., . . . . .	
Ash, . . . . .	
Total phosphoric acid, . . . . .	
Soluble phosphoric acid, . . . . .	
Reverted phosphoric acid (7½ cents per pound), . . . .	
Insoluble phosphoric acid (3 cents per pound), . . . .	
Calcium oxide, . . . . .	
Potassium oxide, . . . . .	
Nitrogen (17 cents per pound), . . . . .	
Insoluble matter, . . . . .	
Valuation per ton, . . . . .	

5. *Analyses, etc.* — Continued.*Dissolved Bone-black.*

[Sent on from Amherst, Mass.]

	PER CENT.	
	I.	II.
100° C., . . . . .	16.84	17.41
. . . . .	56.83	56 19
oric acid, . . . . .	22.18	21.70
phoric acid, . . . . .	14.27	15.60
osphoric acid, . . . . .	7.53	6.02
osphoric acid, . . . . .	.38	.08
tter, . . . . .	3.92	3.99
r ton, . . . . .	\$34 59	\$34 10

*Bone Coal.*

[Sent on by Chas. S. Young, Wellesley Hills, Mass.]

	Per Cent.
100° C., . . . . .	18 16
. . . . .	72.24
oric acid, . . . . .	25.58
phoric acid (8 cents per pound), . . . . .	.38
osphoric acid (7½ cents per pound), . . . . .	5.18
osphoric acid (5 cents per pound), . . . . .	20.02
tter, . . . . .	.69
r ton, . . . . .	\$28 40

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5. *Analyses, etc.* — Continued.*Ground Bones.*

[I., II. and III. sent on by Geo. Frost, Boston, Mass.; IV. sent on by L. B. Eastham, Mass.]

*Mechanical Analyses.*

	PER CENT.		
	I.	II.	III.
Fine, smaller than $\frac{1}{8}$ inch, . . . .	28.96	56.50	33.25
Fine medium, smaller than $\frac{1}{16}$ inch, . .	59.98	38.18	28.65
Medium, smaller than $\frac{1}{32}$ inch, . . . .	11.06	5.32	21.78
Coarser than $\frac{1}{16}$ inch, . . . .	—	—	16.32
	100.00	100.00	100.00

*Chemical Analyses.*

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . .	5.59	5.85	4.18
Ash, . . . .	58.07	38.79	49.80
Total phosphoric acid, . . . .	20.08	19.90	19.32
Soluble phosphoric acid, . . . .	.30	.17	.37
Reverted phosphoric acid, . . . .	5.46	7.86	9.36
Insoluble phosphoric acid, . . . .	14.32	12.67	9.59
Nitrogen, . . . .	3.88	5.90	4.72
Insoluble matter, . . . .	1.48	.48	.40

5. *Analyses, etc.*—Continued.

*Bones.*

Edward H. Smith, Northborough, Mass.; II. sent on by Franklyn  
ew Bedford, Mass.; III. sent on by Edmund Hersey, Hingham,  
sent on by S. Winter, Brockton, Mass.]

*Mechanical Analyses.*

	PER CENT.			
	I.	II.	III.	IV.
than $\frac{1}{8}$ inch, . . . .	37.90	46.00	62.29	57.33
, smaller than $\frac{1}{8}$ inch, . .	38.80	36.52	30.81	24.13
llar than $\frac{1}{8}$ inch, . . . .	19.50	17.48	6.28	9.74
$\frac{1}{8}$ inch, . . . . .	4.80	—	.62	8.80
	100.00	100.00	100.00	100.00

*Chemical Analyses.*

	PER CENT.			
	I.	II.	III.	IV.
00° C., . . . . .	4.33	4.21	5.07	8.03
. . . . .	57.06	74.04	55.04	60.60
oric acid, . . . . .	22.40	29.42	25.19	23.66
phoric acid, . . . . .	.43	.45	.14	.51
sporic acid, . . . . .	6.17	13.17	10.80	12.18
sporic acid, . . . . .	15.80	15.80	14.25	10.97
. . . . .	4.04	2.08	3.07	4.20
ter, . . . . .	1.65	.31	.55	.72

*Dried Blood.*

[Sent on from Amherst, Mass.]

	Per Cent.
00° C., . . . . .	15.02
cents per pound), . . . . .	8.24
ton, . . . . .	\$31.31

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## 270 AGRICULTURAL EXPERIMENT STATION.

### 5. Analyses, etc. — Continued.

*Sulphate of Ammonia.*

[Sent on from Amherst, Mass.]

Moisture at 100° C.,	.	.	.	.	.	.	.	.
Nitrogen (19 cents per pound),	.	.	.	.	.	.	.	.
Sulphuric acid,	.	.	.	.	.	.	.	.
Valuation per ton,.	.	.	.	.	.	.	.	.

### *Nitrate of Soda.*

[Sent on from Amherst, Mass.]

	PER CENT
	I.
Moisture at 100° C., . . . . .	3.22
Sodium oxide, . . . . .	53.44
Nitrogen (17 cents per pound), . . . . .	15.30
Insoluble matter, . . . . .	.19
Valuation per ton, . . . . .	\$52 02

*Saltpetre Waste (from Gunpowder Works).*

[Sent on by A. N. Stowe, Hudson, Mass.]

Moisture at 100° C.,	.	.	.	.	.	.	.
Calcium oxide,	.	.	.	.	.	.	.
Magnesium oxide,	.	.	.	.	.	.	.
Sodium oxide,	.	.	.	.	.	.	.
Potassium oxide (4½ cents per pound),	.	.	.	.	.	.	.
Sulphuric acid,	.	.	.	.	.	.	.
Nitrogen (17 cents per pound),	.	.	.	.	.	.	.
Chlorine,	.	.	.	.	.	.	.
Insoluble matter,	.	.	.	.	.	.	.
Valuation per ton,	.	.	.	.	.	.	.

5. *Analyses, etc.* — Continued.*Wool Waste.*

F. D. Barker, South Acton, Mass.; II. sent on by C. W. Mann,  
Methuen, Mass.]

	PER CENT.	
	I.	II.
° C., . . . . .	8.53	3.46
. . . . .	—	59.41
le (4½ cents per pound), . . . . .	Trace.	3.08
d (6 cents per pound), . . . . .	.115	.29
nts per pound), . . . . .	10.195	1.18
er, . . . . .	3.480	49.57
ton, . . . . .	\$16 45	\$4 86

*“Mud Crab.”*

[Sent on by L. B. Smith, Eastham, Mass.]

	Per Cent.
° C., . . . . .	7.67
. . . . .	6.71
ic acid (6 cents per pound), . . . . .	1.25
phoric acid, . . . . .	.28
phoric acid, . . . . .	.62
phoric acid, . . . . .	.35
nts per pound), . . . . .	8.84
er, . . . . .	.91

*Tobacco Dust.*

[Sent on from Syracuse, N. Y.]

	Per Cent.
° C., . . . . .	12.98
e (4½ cents per pound), . . . . .	9.04
l (6 cents per pound), . . . . .	2.09
nts per pound), . . . . .	3.00
er, . . . . .	.40
on, . . . . .	\$20 39

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5. *Analyses, etc.* — Continued.*Linseed Refuse.*

[Sent on by John King, South Framingham, Mass.]

	Fine.	Coarse.
100° C., . . . . .	6.440	6.230
. . . . .	7.370	5.330
ide (4½ cents per pound), . . . . .	.679	.802
id (6 cents per pound), . . . . .	1.525	1.188
cents per pound), . . . . .	7.080	4.680
ter, . . . . .	.495	.112
ton, . . . . .	\$28 84	\$22 29

*Cotton-seed Fertilizer.*

[Sent on by Geo. W. Wright, Concord, Mass.]

	Per Cent.
100° C., . . . . .	7.950
, . . . . .	.429
ide, . . . . .	.672
. . . . .	.066
ide (4½ cents per pound), . . . . .	1.194
id (6 cents per pound), . . . . .	1.241
cents per pound), . . . . .	8.000
ter, . . . . .	1.187
ton, . . . . .	\$26 50

*Oak Leaves.*

[Sent on by W. H. Hillman, Forestdale, Mass.]

	Per Cent.
100° C., . . . . .	9.601
. . . . .	6.840
, . . . . .	.548
ide, . . . . .	.267
. . . . .	.027
ide (4½ cents per pound), . . . . .	.058
id (6 cents per pound), . . . . .	.549
cents per pound), . . . . .	.930
. . . . .	.018
a, . . . . .	4.333
ton, . . . . .	\$3 87

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5. *Analyses, etc.* — Continued.

### Chaff from Grain Elevator.

[Sent on by S. H. Pierce, Lincoln, Mass.]

Moisture at 100° C.,	.	.	.	.	.	.	.	.
Ash,	.	.	.	.	.	.	.	.
Potassium oxide (4½ cents per pound),	.	.	.	.	.	.	.	.
Phosphoric acid (6 cents per pound),	.	.	.	.	.	.	.	.
Nitrogen (17 cents per pound),	.	.	.	.	.	.	.	.
Insoluble matter,	.	.	.	.	.	.	.	.
Valuation per ton,	.	.	.	.	.	.	.	.

*Jute Waste.*

[Sent on by J. E. Stevens, Ludlow, Mass.]

Moisture at 100° C.,	.	.	.	.	.	.	.	.
Ash,	.	.	.	.	.	.	.	.
Calcium oxide,	.	.	.	.	.	.	.	.
Ferric oxide,	.	.	.	.	.	.	.	.
Potassium oxide (4½ cents per pound),	.	.	.	.	.	.	.	.
Phosphoric acid (6 cents per pound),	.	.	.	.	.	.	.	.
Nitrogen (13 cents per pound),	.	.	.	.	.	.	.	.
Insoluble matter,	.	.	.	.	.	.	.	.
Valuation per ton,	.	.	.	.	.	.	.	.

*Hemp Waste.*

[Sent on by J. E. Stevens, Ludlow, Mass.]

Moisture at 100° C.,	.	.	.	.	.	.	.	.	.
Ash,	.	.	.	.	.	.	.	.	.
Calcium oxide,	.	.	.	.	.	.	.	.	.
Ferric oxide,	.	.	.	.	.	.	.	.	.
Potassium oxide ( $\frac{1}{2}$ cents per pound),	.	.	.	.	.	.	.	.	.
Phosphoric acid (6 cents per pound),	.	.	.	.	.	.	.	.	.
Nitrogen (13 cents per pound),	.	.	.	.	.	.	.	.	.
Insoluble matter,	.	.	.	.	.	.	.	.	.
Valuation per ton,	.	.	.	.	.	.	.	.	.

### *Cranberry Vines.*

[Sent on by L. B. Smith, Eastham, Mass.]

Moisture at 100° C.,	.	.	.	.	.	.	.	.
Ash,	.	.	.	.	.	.	.	.
Calcium oxide,	.	.	.	.	.	.	.	.
Magnesium oxide,	.	.	.	.	.	.	.	.

5. *Analyses, etc.* — Continued.

	Per Cent.
. . . . .	.087
. . . . .	.080
le (4½ cents per pound), . . . . .	.929
d (6 cents per pound), . . . . .	.268
ents per pound), . . . . .	.770
er, . . . . .	.834
ton, . . . . .	\$3 22

*Salt Hay.*

[Sent on by L. B. Smith, Eastham, Mass.]

	Per Cent.
° C., . . . . .	5.360
. . . . .	.371
ide, . . . . .	.335
. . . . .	.028
. . . . .	.017
le (4½ cents per pound), . . . . .	.718
d (6 cents per pound), . . . . .	.248
ents per pound), . . . . .	1.180
ton, . . . . .	\$4 92

*Compound Fertilizers.*

I. D. Graves, Sunderland, Mass.; II. sent on by S. G. Hubbard, Whately, Mass.]

	PER CENT.	
	I.	II.
° C., . . . . .	14.17	8.92
ric acid, . . . . .	15.79	6.86
horic acid, . . . . .	6.88	4.77
phoric acid, . . . . .	4.43	1.58
phoric acid, . . . . .	4.48	.51
le, . . . . .	2.56	10.31
. . . . .	2.60	6.82
er, . . . . .	5.44	3.67

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## 276 AGRICULTURAL EXPERIMENT STATION.

5. *Analyses, etc.* — Continued.*Compound Fertilizers.*

[I. sent on by C. A. Bartlett, Worcester, Mass.; II. sent on by E. C. Smith, Mass.; III. sent on by W. H. Porter, Agawam, Mass.; IV. sent on by F. W. J. Gerrish, North Worcester, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	17.92	8.71	6.41
Ash, . . . . .	56.65	60.15	72.65
Total phosphoric acid, . . . . .	7.87	16.71	15.04
Soluble phosphoric acid, . . . . .	3.55	4.53	5.44
Reverted phosphoric acid, . . . . .	1.99	3.67	4.29
Insoluble phosphoric acid, . . . . .	2.33	8.51	5.31
Potassium oxide, . . . . .	3.78	4.70	2.16
Nitrogen, . . . . .	2.06	3.12	2.42
Insoluble matter, . . . . .	9.93	5.55	7.50

*Barn-yard Manure.*

[Sent on from Amherst.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	73.470	73.520	76.160
Organic and volatile matter, . . . . .	85.900	93.087	95.915
Ash, . . . . .	14.100	6.913	4.085
Calcium oxide, . . . . .	.264	.185	.302
Magnesium oxide, . . . . .	.182	.158	.180
Potassium oxide (4½ cents per pound), . . . . .	.615	.487	.804
Phosphoric acid (6 cents per pound), . . . . .	.133	.189	.218
Nitrogen (17 cents per pound), . . . . .	.362	.338	.570
Insoluble matter, . . . . .	12.657	6.038	2.131
Valuation per ton, . . . . .	\$1.94	\$1.82	\$2.92

5. *Analyses, etc. — Concluded.*

*Barn-yard Manure.*  
[Sent on from Amherst.]

	PER CENT.		
	I.	II.	III.
0° C., . . . . .	70.160	56.710	72.810
le matter, . . . . .	86.553	87.526	95.809
. . . . .	13.447	12.474	4.191
, . . . . .	.323	.386	—
ide, . . . . .	.271	.223	—
de (4½ cents per pound), . . . . .	.614	.486	.562
d (6 cents per pound), . . . . .	.553	.399	.745
cents per pound), . . . . .	.486	.419	.672
er, . . . . .	11.991	9.873	2.250
ton, . . . . .	\$2 86	\$2 34	\$3 68

No. III. From State Experiment Station.

6. *Miscellaneous Analyses.*

*Ensilage Liquor.*

ames Cheesman, Boston, Mass. Specific gravity, 1.015; tempera- ture, 17° C.]	Per Cent.
lated to acetic acid), . . . . .	2.66
0° C., . . . . .	96.21
. . . . .	3.79
. . . . .	.91
, . . . . .	.015
ide, . . . . .	.003
. . . . .	.227
. . . . .	.001
de, . . . . .	.155
id, . . . . .	.001
mmoniates, . . . . .	.023
trates, . . . . .	.008
buminoids, . . . . .	.002
, . . . . .	.056

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## 278 AGRICULTURAL EXPERIMENT STATION

## 6. Miscellaneous Analyses—Concluded.

**"Nicotinia" (Insecticide).**

[Sent on from Syracuse, N. Y.]

Moisture at 100° C.,	.	.	.	.	.	.	.	.
Ash,	.	.	.	.	.	.	.	.
Calcium oxide,	.	.	.	.	.	.	.	.
Magnesium oxide,	.	.	.	.	.	.	.	.
Potassium oxide (4½ cents per pound),	.	.	.	.	.	.	.	.
Phosphoric acid (6 cents per pound),	.	.	.	.	.	.	.	.
Nitrogen (17 cents per pound),	.	.	.	.	.	.	.	.
Insoluble matter,	.	.	.	.	.	.	.	.
Valuation per ton,	.	.	.	.	.	.	.	.

*Hellebore (Insecticide).*

[Sent on by Joseph Breck & Son, Boston, Mass.]

	PER CENT
	I.
Ash, . . . . .	6.97
One hundred parts of ash contained:—	
Ferric and aluminic oxides, . . . . .	—
Insoluble matter, . . . . .	33.65

No. II. was evidently adulterated with ground clay.

*Peroxide of Silicate (Insecticide).*

[Sent on from Amherst, Mass.]

Moisture at 100° C.,	.	.	.	.	.	.	.	.	.
Calcium oxide,	.	.	.	.	.	.	.	.	.
Sulphuric acid,	.	.	.	.	.	.	.	.	.
Arsenious oxide,	.	.	.	.	.	.	.	.	.
Copper oxide,	.	.	.	.	.	.	.	.	.
Insoluble matter.	.	.	.	.	.	.	.	.	.

Gypsum, with a trace of Paris green.

## ANALYSES OF WATER SENT ON FOR EXAMINATION.

[Parts per million.]

Albuminoid Am- monia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
.06	Trace.	41.00	11.00	1.11	None.	Upton.
.07	5.00	45.00	10.00	1.27	None.	Amherst.
.14	13.00	157.00	89.00	3.25	None.	Amherst.
.15	32.00	203.00	118.00	3.25	None.	Amherst.
.04	11.00	96.00	24.00	1.27	Present.	Framingham.
.08	12.00	108.00	30.00	2.60	None.	Framingham.
.01	10.00	72.00	44.00	2.73	-	Hinsdale.
.07	9.00	160.00	85.00	3.25	None.	Amherst.
.04	24.00	146.00	46.00	3.12	None.	Amherst.
.18	Trace.	45.00	5.00	1.27	None.	Amherst.
.04	6.00	25.00	5.00	0.00	-	Ashfield.
.04	Trace.	68.00	28.00	2.86	-	Ashfield.
.06	7.00	58.00	40.00	0.00	None.	Bedford.
.28	22.00	135.00	70.00	3.38	None.	Westford.
.18	20.00	85.00	20.00	3.38	-	Westford.
.15	96.00	558.00	325.00	13.01	None.	South Deerfield.
.07	Trace.	70.00	45.00	1.56	None.	North Amherst.
.07	30.00	85.00	18.00	2.60	Present.	Amherst.
.07	Trace.	93.00	30.00	3.90	None.	Amherst.
.12	Trace.	60.00	30.00	0.00	None.	Ashby.
.09	4.00	130.00	68.00	2.73	None.	East Amherst.
.05	7.00	91.00	43.00	.79	None.	North Leverett.
.05	10.00	60.00	15.00	.32	Present.	Shutesbury.
1.80	40.00	765.00	410.00	9.71	-	Amherst.
.12	7.00	92.00	22.00	6.43	Present.	Amherst.
.01	78.00	389.00	139.00	7.83	-	Amherst.
.07	Trace.	57.00	12.00	2.60	None.	Amherst.
.08	Trace.	74.00	27.00	2.34	Present.	Amherst.
.06	12.00	135.00	70.00	3.64	None.	Amherst.

## 280 AGRICULTURAL EXPERIMENT STATION.

## II. ANALYSES OF WATER — Continued.

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
30.	.01	.06	Trace.	112.00	42.00	2.47	None.	East Amherst.
31.	.04	.05	Trace.	46.00	10.00	.47	None.	Amherst.
32.	.13	.10	6.00	147.00	92.00	4.57	None.	South Amherst.
33.	.17	.06	6.00	111.00	66.00	4.57	None.	Amherst.
34.	.84	.10	34.00	370.00	137.00	6.71	None.	Sunderland.
35.	.05	.05	6.00	88.00	42.00	2.21	—	Amherst.
36.	.01	.03	8.00	180.00	80.00	3.90	None.	Leverett.
37.	.01	.01	Trace.	30.00	00.00	1.11	None.	Amherst.
38.	.01	.10	12.00	95.00	5.00	1.95	—	Amherst.
39.	.01	.16	Trace.	49.00	10.00	2.34	None.	South Boston.
40.	.05	.12	Trace.	47.00	9.00	2.34	None.	South Boston.
41.	.03	.03	7.00	93.00	51.00	2.73	None.	Amherst.
42.	.21	.07	3.00	61.00	25.00	2.21	None.	North Amherst.
43.	.02	.07	22.00	168.00	78.00	4.57	None.	Amherst.
44.	.03	.16	Trace.	52.00	12.00	.32	—	Amherst.
45.	.05	.03	Trace.	74.00	18.00	1.95	None.	South Amherst.
46.	.06	.13	8.00	128.00	68.00	2.60	Present.	Amherst.
47.	.01	.12	Trace.	40.00	6.00	.32	—	Amherst.
48.	.03	.10	Trace.	42.00	20.00	.32	—	Amherst.
49.	.03	.11	10.00	158.00	90.00	2.34	—	Amherst.
50.	.01	.04	Trace.	50.00	38.00	1.27	None.	Amherst.
51.	.03	.24	Trace.	50.00	8.00	.16	—	Amherst.
52.	.14	.22	Trace.	140.00	86.00	4.57	—	Amherst.
53.	.01	.06	5.00	110.00	90.00	2.34	None.	Amherst.
54.	.10	.26	6.00	74.00	42.00	4.16	None.	Hudson.
55.	.72	.16	13.00	156.00	98.00	5.29	—	Amherst.
56.	.06	.26	7.00	68.00	22.00	.79	None.	Ashburnham.
57.	.12	.08	10.00	90.00	30.00	2.60	—	Bedford.
58.	.08	.08	35.00	210.00	160.00	5.29	Present.	Bedford.
59.	.00	.04	8.00	77.00	47.00	2.21	—	Bedford.

## II. ANALYSES OF WATER — Concluded.

Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
.03	8.00	70.00	35.00	1.95	None.	Bedford.
.06	6.00	75.00	40.00	.48	None.	East Deerfield.
.03	4.00	20.00	00.00	.00	None.	East Deerfield.
.02	8.00	75.00	40.00	2.21	None.	North Amherst.
.07	7.00	138.00	78.00	1.56	None.	Deerfield.
.03	21.00	178.00	150.00	2.60	None.	Amherst.
.05	19.00	68.00	50.00	2.60	None.	Amherst.
.05	7.00	78.00	18.00	.48	None.	North Hadley.
.06	11.00	114.00	56.00	2.86	None.	East Buckland.
.10	10.00	96.00	68.00	2.99	—	Buckland.
.07	17.00	280.00	190.00	2.86	—	Sunderland.
.05	20.00	236.00	146.00	4.57	None.	Amherst.
.02	10.00	88.00	26.00	1.95	None.	North Amherst.
.05	6.00	40.00	18.00	1.43	None.	North Amherst.
.03	4.00	16.00	6.00	.16	None.	North Amherst.

Analyses have been made according to Wanklyn's method, familiar to chemists, and are directed towards the detection of the presence of chlorine, free and albuminoid ammonia, and the poisonous metals, lead in particular. For a more detailed description of this method, see "Water Analyses," by J. A. Wanklyn and E. T. Andrews.

Wanklyn's interpretation of the results of his method of examination is as follows:—

The presence of chlorine alone does not necessarily indicate the presence of filthy water.

The presence of albuminoid ammonia in water, without the presence of chlorine, indicates a vegetable source of contamination.

Water containing more than five grains per gallon\* of chlorine (=71.4 grains per gallon), accompanied by more than .08 parts per

\* One gallon equals 70,000 grains.



million of free ammonia and more than .10 parts per million of albuminoid ammonia, is a clear indication that the water is contaminated with sewage, decaying animal matter, etc., and should be condemned.

4. Eight hundredths parts per million of free ammonia and one-tenth part per million of albuminoid ammonia should render a water very suspicious, even without much chlorine.

5. Albuminoid ammonia, over .15 parts per million, ought to absolutely condemn a water which contains it.

6. The total solids found in the water should not exceed forty grains per gallon (571.4 parts per million).

The American Association of Official Chemists has appointed a committee to investigate the subject of the quality of water for family use, and to advise upon some uniform method of investigation and of reporting the results. As soon as their recommendation shall be endorsed by the association, we propose to be guided by that decision.

An examination of the previously stated results of analyses, indicate that Nos. 3, 5, 10, 11, 16, 18, 20, 25, 27, 28, 32, 33, 34, 42, 46, 52, 54, 57 and 58, are to be condemned as unfit for family use, while Nos. 1, 2, 6, 66 and 68 must be considered suspicious. From this it will be seen that over one-fourth of the entire number of well waters tried proved unfit for drinking. Heating well waters to the boiling point removes, not unfrequently, the immediate danger. Seven samples gave unmistakable evidence of the presence of lead.

Parties sending on water for analysis ought to be careful to use clean vessels, clean stoppers, etc. All samples should be sent on without delay after collection. One gallon is desirable for the analysis.

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REPORT OF ANALYSES MADE AT AMHERST, MASS., OF  
AGRICULTURAL CHEMICALS AND REFUSE MATERIALS  
USED FOR FERTILIZING PURPOSES.

PREPARED BY W. H. BEAL.

[On basis of valuation changes from year to year, no valuation is stated.]

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1868-1890.

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This publication does not include the analyses made of licensed fertilizers. They are found in the reports of the State Inspector of Fertilizers from 1873 to 1889, and in the reports of the Secretary of the Massachusetts State Board of Agriculture for those years.

C. A. G.

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	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOS- PHORIC ACID.			Soluble Phosphoric Acid.							Ferric and Alum- bic (Oxide).	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.	
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Reverted Phos- phoric Acid.	Insoluble Phos- phoric Acid.	Soda.	Lime.	Magnesia.								
<i>I. Chemicals, Refuse Salts, Ashes, etc.</i>																									
Muriate of potash,	. . . . .	45	2.00	-	-	-	58.98	45.94	52.46	-	-	-	-	-	-	6.80	-	.55	-	-	-	-	48.40	.75	
Sulphate of potash,	. . . . .	15	1.25	-	-	-	51.28	21.36	38.80	-	-	-	-	-	-	4.46	-	1.50	-	-	45.72	-	-	.75	
Sulphate of potash and magnesia,	. . . . .	13	4.75	-	-	-	27.77	18.92	23.50	-	-	-	-	-	-	6.25	2.57	12.25	-	-	44.25	-	2.60	1.41	
Kainite, . . . . .	. . . . .	3	3.20	-	-	-	16.48	12.61	13.54	-	-	-	-	-	-	18.97	1.12	10.25	-	-	21.05	-	34.32	1.27	
Carnallite, . . . . .	. . . . .	1	-	-	-	-	-	-	13.68	-	-	-	-	-	-	7.66	-	13.19	-	-	.56	-	41.56	-	
Krugite, . . . . .	. . . . .	1	4.82	-	-	-	-	-	8.42	-	-	-	-	-	-	5.57	12.45	8.79	-	-	31.94	-	6.03	14.96	
Sulphate of magnesia ( <i>Kieserite</i> ), . . . . .	. . . . .	9	22.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.73	
Nitrate of potash, . . . . .	. . . . .	2	1.93	-	-	-	14.58	11.60	13.09	45.62	44.76	45.19	-	-	-	-	-	-	-	-	-	-	-	-	
Nitrate of soda, . . . . .	. . . . .	14	1.40	-	-	-	16.01	15.30	15.75	-	-	-	-	-	-	35.25	-	-	-	-	-	-	.50	.50	
Sulphate of ammonia, . . . . .	. . . . .	23	1.00	-	-	-	21.66	19.70	20.50	-	-	-	-	-	-	-	-	-	-	-	60.00	-	-	trace	
Saltpetre waste, . . . . .	. . . . .	8	2.75	-	-	-	3.30	.59	2.43	30.94	1.85	15.50	-	-	-	34.25	.75	.19	-	-	1.85	-	48.30	-	
Nitre salt-cake, . . . . .	. . . . .	2	6.03	-	-	-	-	-	.87	-	-	-	-	-	-	29.56	-	-	-	-	47.77	-	-	3.92	
Wood ashes, . . . . .	. . . . .	116	12.00	-	-	-	7.96	2.93	5.95	4.61	.51	1.75	-	-	-	-	34.80	3.25	.83	-	-	-	-	12.50	

Sea-weed ashes, . . . . .	1	1.47	-	-	-	-	.92	-	-	.30	-	-	-	-	53.85	.75	-	45.75	-	-	2.50
Nova Scotia plaster, . . . . .	10	6.50	-	-	-	-	-	-	-	-	-	-	-	-	30.00	4.68	-	32.50	8.20	-	9.83
Onondaga plaster, . . . . .	4	13.27	-	-	-	-	-	-	-	-	-	-	-	-	43.66	8.30	-	20.73	-	-	6.05
Gas-house lime, . . . . .	3	22.23	-	-	-	-	-	-	-	-	-	-	-	-	27.51	-	-	-	-	-	.32
Lime waste from sugar factory, . . . . .	1	36.30	-	-	-	-	-	.22	-	2.25	-	-	-	-	44.80	2.60	-	17.75	-	-	8.25
Lime-kiln ashes, . . . . .	7	15.45	-	-	-	-	1.70	.02	.86	3.16	.36	1.18	-	-	40.07	.64	.69	28.51	-	-	3.44
Marls (Massachusetts), . . . . .	5	18.18	-	-	-	-	-	-	-	2.72	.96	1.05	-	-	7.25	.21	-	.86	7.25	-	64.23
Marls (Virginia), . . . . .	2	15.98	-	-	-	-	.61	.37	.49	.09	.03	.09	-	-	21.96	.61	-	-	-	-	50.18
Marl (North Carolina), . . . . .	1	1.50	-	-	-	-	-	-	.04	-	-	.56	-	-	-	-	-	-	-	-	-
<i>II. Guanos, Phosphates, etc.</i>																					
Peruvian guano, . . . . .	26	14.81	37.61	13.50	4.44	7.85	4.08	1.14	2.61	20.60	5.96	15.26	4.57	3.79	6.90	-	-	-	-	-	6.00
Bat guano, from Texas, . . . . .	9	40.09	18.24	10.51	2.58	8.47	-	-	1.31	6.53	1.00	3.78	-	-	-	-	-	-	-	-	2.00
Cuba guano, . . . . .	5	24.27	.67	2.74	.63	1.67	-	-	-	16.16	11.54	13.35	-	-	-	-	-	-	-	-	3.17
Caribbean guano ( <i>Orchilla</i> ), . . . . .	12	7.31	-	-	-	-	-	-	-	35.43	18.11	26.77	-	-	-	39.95	3.29	-	2.08	-	1.27
South Carolina rock phosphate, . . . . .	4	1.50	-	-	-	-	-	-	-	30.51	25.81	26.03	.27	.33	27.43	41.87	3.03	4.80	-	-	11.61
Navassa phosphate, . . . . .	2	7.60	-	-	-	-	-	-	-	34.45	34.06	34.27	-	-	-	37.45	-	10.27	-	-	2.70
Brockville phosphate, . . . . .	1	2.50	-	-	-	-	-	-	-	-	-	35.21	-	-	-	-	-	-	-	-	6.46
Phosphatic slag, . . . . .	3	1.45	-	-	-	-	-	-	-	30.51	18.91	23.49	-	-	3.06	21.65	-	3.42	10.12	-	9.40

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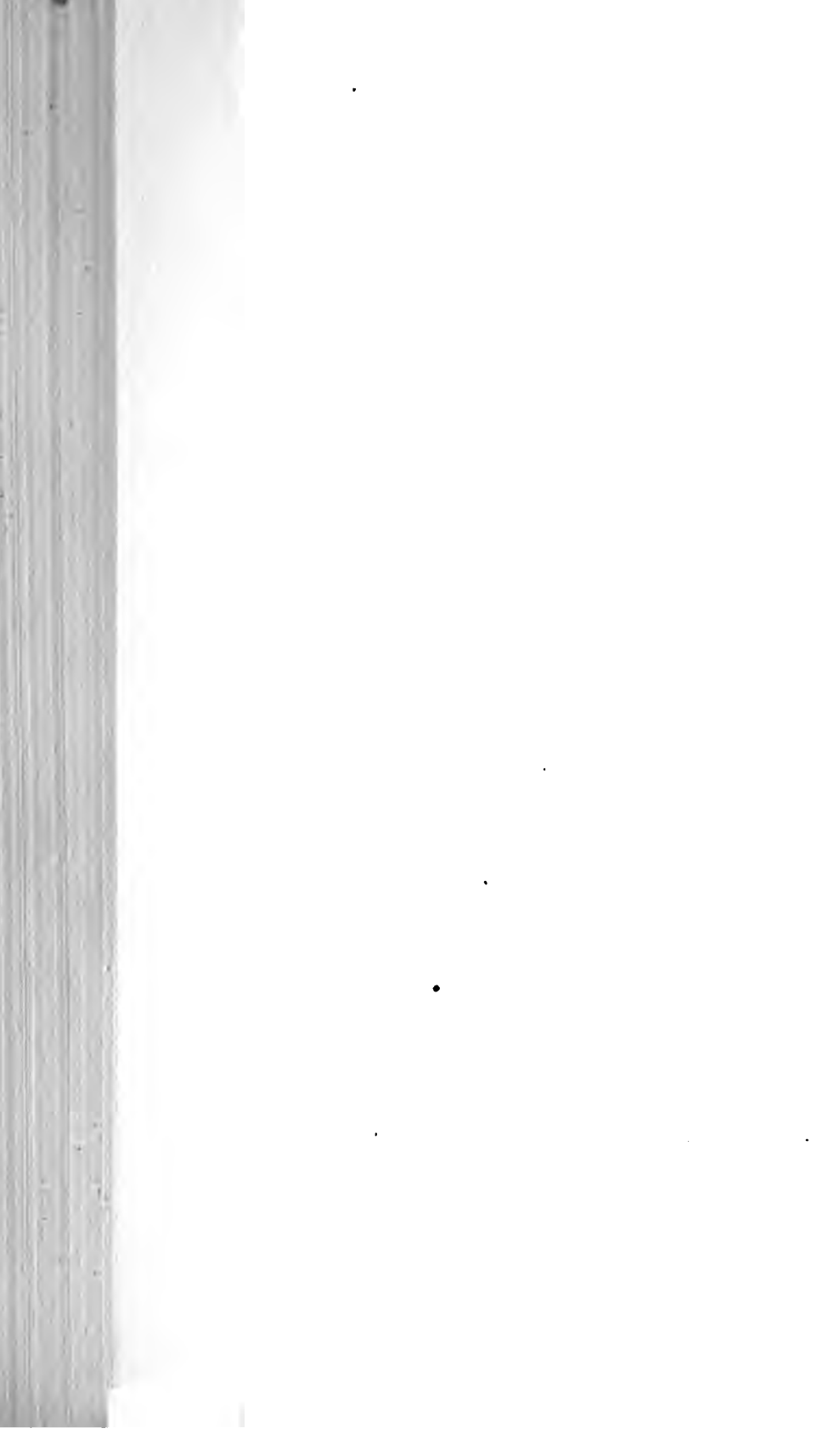
	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOS- PHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phos- phoric Acid.	Insoluble Phos- phoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Alumi- nic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
<i>II. Guanos, Phosphates, etc. — Concluded.</i>																							
Bone-black, . . . . .	5	4.60	-	-	-	-	-	-	-	30.54	16.56	23.28	-	-	-	-	-	-	-	-	-	-	3.64
South American bone-ash, . . . .	1	7.00	-	-	-	-	-	-	-	-	-	35.89	-	-	-	-	44.80	-	-	-	-	-	4.50
<i>III. Refuse Substances.</i>																							
Dried blood, . . . . .	12	12.50	6.37	13.53	8.10	10.52	-	-	-	6.23	1.53	1.91	-	-	-	-	-	-	-	-	-	-	-
Ammonite, . . . . .	1	5.88	-	-	-	11.33	-	-	-	-	-	3.43	-	-	-	-	-	-	-	-	-	-	1.88
Oleomargarine refuse, . . . . .	1	8.54	14.42	-	-	12.12	-	-	-	-	-	.88	-	-	-	-	-	-	-	-	-	-	.96
Felt refuse, . . . . .	1	29.24	33.53	-	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.44
Sponge refuse, . . . . .	1	7.25	-	-	-	2.43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39.06
Horn and hoof waste, . . . . .	3	10.17	7.63	15.40	11.84	13.25	-	-	-	2.30	1.36	1.83	-	-	-	3.94	1.27	-	-	-	-	-	.24
Raw wool, . . . . .	1	6.95	7.64	-	-	12.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.63
Wool waste, . . . . .	6	9.27	-	10.20	1.18	5.64	3.08	.54	1.30	-	-	.29	-	-	-	.07	.07	.07	-	-	-	-	4.60
Wool washings (water), . . . . .	1	-	-	-	-	-	-	-	3.92	-	-	-	-	-	-	.49	.28	-	-	-	-	-	-



	Analyses.	Molature.	Ash.	NITROGEN.			POTASH.			TOTAL PHOS- PHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phos- phoric Acid.	Insoluble Phos- phoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Alumi- nic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances—Concluded.																							
Sumac waste, . . . . .	1	63.06	6.80	-	-	1.19	-	-	3.75	-	-	-	-	-	-	-	1.14	3.25	-	-	-	-	2.25
Kel-grass, . . . . .	2	35.39	15.60	.96	.70	.63	1.61	.21	.91	.41	.22	.32	-	-	-	1.63	2.13	.11	-	-	-	-	1.06
Rockweed, green, . . . . .	1	68.50	23.70	-	-	.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockweed, dry, . . . . .	1	10.68	35.75	-	-	1.45	-	-	4.88	-	-	2.75	-	-	-	7.90	7.66	.21	-	-	-	-	10.40
Wet kelp, . . . . .	1	88.04	2.26	-	-	.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mussel mud, wet, . . . . .	1	60.01	27.29	-	-	.21	-	-	6.17	-	-	.10	-	-	-	.70	.93	.14	3.48	-	-	-	-
Mussel mud, dry, . . . . .	1	2.24	72.02	-	-	.72	-	-	-	-	-	.35	-	-	-	-	23.39	-	8.26	-	-	-	37.60
Salt mud, . . . . .	2	53.37	41.19	.40	.39	.40	.93	.32	.33	-	-	-	-	-	-	.64	.91	.37	4.13	-	-	-	34.88
Fresh-water mud, . . . . .	1	40.37	-	-	-	1.37	-	-	.22	-	-	.26	-	-	-	-	1.27	.29	1.80	-	-	-	18.26
Black mud, . . . . .	1	56.55	39.60	-	-	1.64	-	-	.38	-	-	-	-	-	-	.86	.91	.66	4.26	-	-	-	31.84
Muck, . . . . .	12	55.13	13.75	2.64	.26	1.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peat, . . . . .	9	61.50	7.71	1.40	.41	.75	-	-	-	-	-	-	-	-	-	-	.50	-	-	-	-	-	.38

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ATION OF ANALYSES OF FODDER ARTI-  
FRUITS, SUGAR-PRODUCING PLANTS,  
DAIRY PRODUCTS, ETC.,

MADE AT

AMHERST, MASS.

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1868-1890.

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PREPARED BY W. H. BEAL.

ALYSES OF FODDER ARTICLES.

ALYSES OF FODDER ARTICLES WITH REFERENCE  
TO FERTILIZING INGREDIENTS.

ALYSES OF FRUIT.

ALYSES OF SUGAR-PRODUCING PLANTS.

RY PRODUCTS.

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CABOT SCIENCE LIBRARY

## A. Analyses of Fodder Articles.

NAME.	Analyses.	ONE HUNDRED PARTS OF DRY MATTER CONTAIN —																Nutritive Ratio (Average)
		DRY MATTER.			PROTEIN.			FAT.		NITROGEN—FREE EXTRACT.			FIBRE.			Ash.		
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.					
<i>I. Green Fodders.</i>																		
Fodder corn, . . . . .	23	30.53	10.34	19.14	17.19	8.04	10.33	6.10	1.42	2.42	63.13	42.02	55.30	31.53	19.26	25.87	5.98	1:7.99
Fodder corn (ensilaged), . . . . .	16	28.40	13.12	20.30	12.58	6.91	8.64	6.07	1.94	3.64	65.69	42.99	56.44	35.25	17.67	26.29	4.90	1:10.22
Sorghum, . . . . .	6	23.18	12.38	17.41	11.84	7.46	8.74	2.00	1.21	1.55	64.93	47.65	56.15	29.27	22.00	26.73	6.83	1:11.62
White kibi,* . . . . .	2	24.26	22.85	23.56	15.14	10.79	12.97	1.61	1.50	1.56	53.66	52.30	52.91	31.70	23.03	27.37	5.19	-
Mochi millet,* . . . . .	3	42.27	30.07	37.42	11.60	6.11	9.64	1.94	1.74	1.81	67.06	49.06	55.69	29.80	20.01	25.56	7.00	-
Mix,* . . . . .	3	31.36	18.17	24.45	16.70	9.81	13.53	2.48	1.35	1.66	52.30	47.75	51.27	27.44	26.82	27.06	6.28	-
Green oats, . . . . .	5	28.82	15.51	20.03	20.47	7.05	13.85	8.32	2.02	2.68	50.69	40.81	45.90	33.12	25.2	29.70	7.87	1:9.97
Timothy ( <i>Phleum pratense</i> L.), . . . . .	2	35.00	34.26	34.63	8.83	8.20	8.52	2.07	1.95	2.01	51.33	51.23	51.27	33.23	32.50	32.87	5.33	1:10.96
Hungarian grass ( <i>Setaria Italica</i> Beauv.), . . . . .	1	-	-	25.93	-	-	9.36	-	-	1.01	-	-	57.80	-	-	24.66	7.15	1:6.86
Vetch and oats (1 part vetch, 9 parts oats), . . . . .	2	24.04	13.89	18.97	10.76	10.50	10.68	2.74	2.29	2.52	43.75	40.16	41.91	35.81	34.20	35.01	9.88	1:6.85
Horse bean ( <i>Vicia faba</i> L.), . . . . .	1	-	-	15.17	-	-	16.68	-	-	2.31	-	-	47.09	-	-	28.17	5.75	1:2.71
Cow-pea vines, . . . . .	3	21.19	18.15	19.63	17.63	11.24	14.59	2.99	1.81	2.48	60.62	46.13	52.42	26.86	21.87	23.59	6.92	1:6.82
Serradella ( <i>Ornithopus sativus</i> Brot.), . . . . .	2	19.42	16.40	17.41	17.76	12.17	14.96	2.66	2.09	2.37	41.54	35.45	38.49	38.76	26.21	32.46	11.60	1:4.67

Feed-crop hay ( <i>Agrostis vulgaris</i> Willd.),	4	80.19	81.10	92.30	8.40	6.41	1.66	1.69	1.60	1.90	58.14	60.62	92.63	34.11	31.12	32.92	4.91	1:12.00
Orchard grass ( <i>Dactylis glomerata</i> L.),	4	91.62	90.86	91.17	11.20	7.57	8.99	3.56	2.40	2.91	47.34	43.50	46.15	35.79	34.12	34.66	7.05	1:10.47
Meadow fescue ( <i>Festuca pratensis</i> Huds.),	4	92.60	87.64	90.18	7.27	5.89	6.46	2.17	1.65	1.64	49.18	43.93	47.37	39.90	34.46	36.26	8.04	1:14.32
Perennial rye grass ( <i>Lolium perenne</i> L.),	4	93.64	90.50	92.60	16.56	6.59	11.71	3.15	1.59	2.37	55.77	38.82	46.14	30.86	26.79	29.64	8.14	1:7.40
Italian rye grass ( <i>Lolium italicum</i> A. Br.),	4	92.62	90.70	91.54	9.75	6.20	8.15	2.07	1.39	1.85	52.80	43.09	46.14	36.90	31.27	33.34	7.52	1:10.90
Hungarian grass ( <i>Setaria italica</i> Beauv.),	1	-	-	92.55	-	-	9.45	-	-	2.22	-	-	50.64	-	-	31.96	6.73	1:6.22
Barn-yard grass ( <i>Panicum crus-galli</i> L.),	1	-	-	93.35	-	-	15.27	-	-	1.95	-	-	38.24	-	-	33.72	10.82	1:2.04
Low meadow hay,	1	-	-	91.99	-	-	9.51	-	-	1.88	-	-	46.27	-	-	35.59	6.75	-
Millet,	5	93.85	91.90	93.00	8.11	7.09	7.59	2.67	.89	1.74	55.80	49.62	51.64	35.91	29.80	33.54	5.49	1:7.78
Oats in blossom,	1	-	-	93.57	-	-	6.58	-	-	2.92	-	-	50.03	-	-	34.06	6.41	1:14.23
Oats in milk,	1	-	-	90.45	-	-	10.69	-	-	2.68	-	-	48.02	-	-	34.32	6.08	1:7.90
Oats, ripe,	1	-	-	91.30	-	-	6.05	-	-	2.61	-	-	49.92	-	-	36.31	6.11	1:15.03
Winter rye, in bloom,	1	-	-	91.45	-	-	10.68	-	-	2.57	-	-	47.40	-	-	32.97	6.40	1:8.28
Barley, in milk,	1	-	-	89.75	-	-	10.26	-	-	2.76	-	-	52.91	-	-	29.12	4.95	1:9.59
Corn fodder,	3	93.35	91.17	92.82	8.63	6.17	7.21	2.06	1.11	1.53	55.68	53.86	54.98	33.75	29.05	31.40	4.88	1:11.55
Corn stover,	11	94.23	49.87	91.08	12.15	6.04	7.92	2.63	1.17	1.65	63.05	44.65	53.38	38.24	20.93	32.02	5.03	1:10.88

\* Japanese fodder plants.

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## A. Analyses of Fodder Articles — Continued.

N A M E.	Analyses.	D R Y M A T T E R.			P R O T E I N.			F A T.			N I T R O G E N — F R E E E X T R A C T.			F I B R E.			Ash.	Nutritive Ratio (Average).
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
II. Hay and Dry Coarse Fodder — Concluded.																		
Teosinte ( <i>Euchlena luxurians</i> Dur. and Aech.).	1	-	-	93.94	-	-	9.71	-	-	1.28	-	-	53.18	-	-	28.88	6.95	-
Mammoth red clover ( <i>Trifolium medium</i> L.).	3	92.66	82.47	88.59	18.50	14.06	15.75	2.25	1.86	2.13	48.08	46.51	44.77	33.72	20.16	27.51	9.84	1:5.10
Medium red clover ( <i>Trifolium pratense</i> L.).	1	-	-	93.98	-	-	14.63	-	-	2.62	-	-	43.88	-	-	29.97	8.90	1:5.63
Alsike clover ( <i>Trifolium hybridum</i> L.).	5	93.92	86.48	90.07	17.55	14.77	16.22	3.26	1.88	2.66	46.64	38.03	43.27	32.34	21.44	26.18	11.07	1:3.37
Lucerne (alfalfa) ( <i>Medicago sativa</i> Desr.).	5	95.40	84.00	91.40	16.34	11.12	14.22	2.50	1.64	1.85	51.62	40.25	46.30	34.39	25.42	29.72	8.11	1:4.09
Sand lucerne, in bloom ( <i>M. media</i> Pers.).	1	-	-	91.20	-	-	16.26	-	-	2.59	-	-	50.31	-	-	21.27	9.57	1:3.50
Bokhara clover ( <i>Melilotus alba</i> Desr.).	1	-	-	93.84	-	-	11.81	-	-	1.95	-	-	51.38	-	-	28.08	6.90	-
Blue mulilot ( <i>Melilotus cernua</i> Desr.).	1	-	-	91.78	-	-	13.81	-	-	1.87	-	-	43.22	-	-	27.17	14.87	-
Sulla ( <i>Hedysarum coronarium</i> ).	1	-	-	89.54	-	-	17.03	-	-	3.16	-	-	58.66	-	-	12.38	8.77	-
Hairy lotus ( <i>Lotus villosus</i> Thuill.).	2	89.32	87.64	88.48	16.12	13.49	14.81	3.00	2.69	2.85	67.82	50.80	54.29	24.48	15.07	19.78	8.27	-
Soja bean.	2	93.88	93.52	93.70	15.87	15.10	15.49	6.35	5.62	5.93	51.28	48.25	48.75	21.75	20.76	21.26	7.51	1:4.62
Cow-pea.	3	90.70	90.25	90.43	17.17	16.95	17.05	4.49	3.81	4.06	51.41	46.06	47.93	23.58	19.06	21.67	9.29	1:4.82
Sorradella.	3	92.80	87.23	90.44	17.97	15.26	17.03	2.91	2.37	2.65	60.25	44.49	48.18	25.92	24.37	25.15	7.09	1:4.85
Hairy vetch ( <i>Vicia villosa</i> Lath.).	1	-	-	92.58	-	-	19.59	-	-	1.99	-	-	38.95	-	-	31.69	8.37	-

III. *Roots, Bulbs, Tubers, etc.*

Beets, red, . . . . .	7	14.51	9.75	12.17	15.40	7.82	12.29	1.76	.59	.94	79.33	66.87	72.19	7.66	4.25	6.00	8.58	1:8.24
Beets, sugar, . . . . .	9	19.53	13.05	15.92	17.44	7.32	10.84	.83	.58	.85	81.50	72.79	77.87	6.98	4.82	6.00	4.64	1:12.15
Beets, yellow fodder, . . . . .	1	-	-	9.40	-	-	12.78	-	-	1.80	-	-	67.50	-	-	7.63	10.09	1:8.33
Mangolds, . . . . .	3	13.08	11.73	12.25	12.84	7.83	10.37	1.01	.73	.88	73.38	70.32	71.75	9.54	7.08	7.94	9.06	1:9.94
Ruta-bagas, . . . . .	3	12.77	8.25	10.88	11.46	10.34	11.01	2.32	1.23	1.53	68.58	62.27	65.88	13.12	11.03	11.83	9.75	1:11.83
Turnips, . . . . .	2	12.80	8.23	10.52	10.81	9.67	10.24	1.74	1.42	1.58	70.62	68.80	69.71	10.96	10.12	10.54	7.93	1:13.07
Carrots, . . . . .	3	12.52	9.95	10.82	9.63	7.98	8.64	3.94	1.67	2.50	73.96	67.24	70.98	10.76	7.55	9.53	8.14	1:9.81
Potatoes, . . . . .	10	21.95	13.91	18.78	13.56	6.24	10.01	.83	.17	.48	87.56	78.80	81.50	3.55	1.91	2.75	5.26	1:12.25
Apples, . . . . .	2	24.83	19.68	22.26	4.57	3.92	4.25	2.81	1.71	2.26	86.21	83.44	84.81	7.05	6.14	8.60	2.08	1:26.44
IV. <i>Grains and Other Seeds.</i>																		
Corn kernels, . . . . .	28	91.98	65.50	89.55	15.02	8.49	12.94	9.43	4.25	5.47	83.98	71.06	78.44	3.38	1.03	2.14	1.71	1:8.16
Corn kernels and cobs (corn and cob meal), . . . . .	8	90.55	73.66	85.12	15.06	7.82	11.13	5.27	3.36	4.94	80.87	70.13	75.82	9.77	5.39	7.94	1.67	1:8.63
Wheat grain, . . . . .	1	-	-	89.42	-	-	13.35	-	-	1.79	-	-	80.28	-	-	2.42	2.18	1:6.42
Broom-corn seed, . . . . .	1	-	-	85.90	-	-	11.21	-	-	4.05	-	-	74.05	-	-	8.34	2.35	-
Soja beans ( <i>Soja hispida</i> Münch.), . . . . .	3	94.15	80.73	85.83	35.98	32.58	33.97	21.89	18.42	20.19	84.88	32.87	33.86	7.67	5.15	6.02	5.84	1:2.61
Horse beans ( <i>Vicia faba</i> L.), . . . . .	1	-	-	88.72	-	-	30.03	-	-	1.11	-	-	56.48	-	-	8.11	4.27	1:2.24

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## A. Analyses of Fodder Articles—Concluded.

N A M E.	Analyses.	O N E H U N D R E D P A R T S O F D R Y M A T T E R C O N T A I N —															Ash.	Nutritive Ratio (Average)
		D R Y M A T T E R.			P R O T E I N.			F A T.			N I T R O G E N — F R E E E X T R A C T.			F I B R E.				
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
V. Flour and Meal.																		
Corn meal, . . . . .	18	89.95	82.96	87.24	16.08	10.19	11.28	5.08	3.10	4.35	83.24	73.20	80.34	3.60	1.20	2.42	1.63	1:8.04
Hominy meal, . . . . .	3	91.89	89.30	90.75	11.88	11.20	11.61	12.22	4.89	9.33	78.07	68.00	72.55	4.78	3.69	4.08	2.43	1:8.82
Ground barley, . . . . .	2	87.81	86.39	87.10	11.17	10.42	10.80	2.19	1.66	1.94	78.25	77.45	77.78	7.37	6.85	7.11	2.36	1:9.72
Broom-corn meal, . . . . .	1	-	-	88.46	-	-	11.14	-	-	4.13	-	-	74.30	-	-	8.00	2.43	-
Pea meal, . . . . .	1	-	-	91.15	-	-	20.95	-	-	1.67	-	-	55.02	-	-	19.42	2.94	-
VI. By-products and Refuse.																		
Linseed cake, old process, . . . . .	4	92.52	89.54	90.92	38.67	30.98	36.26	7.98	5.69	6.83	44.72	37.76	41.02	9.69	8.04	8.73	7.16	1:1.67
Linseed cake, new process, . . . . .	2	93.99	91.42	92.71	40.76	32.50	36.63	3.18	3.14	3.16	46.49	40.83	42.66	10.31	9.23	9.77	6.78	1:1.45
Cotton-seed meal, . . . . .	7	93.16	90.11	91.92	47.04	18.17	42.22	14.72	5.22	13.48	54.55	25.03	29.02	14.80	6.28	8.22	8.06	1:1.45
Wheat bran, . . . . .	20	91.90	86.30	89.30	20.24	15.67	17.56	6.08	2.80	4.63	62.18	56.89	59.87	14.26	7.49	10.83	6.91	1:3.85
Wheat middlings, . . . . .	3	90.75	89.45	90.45	19.21	17.23	18.21	6.46	3.19	4.63	74.30	61.62	69.60	8.40	1.40	4.11	3.45	1:4.10
Wheat shorts, . . . . .	2	91.13	89.67	90.40	17.28	16.71	17.00	5.86	5.52	5.69	61.71	58.03	59.86	11.21	8.58	9.80	7.55	1:4.09
Rye bran, . . . . .	2	91.82	86.30	89.06	18.98	16.52	17.75	3.03	2.07	2.55	73.56	69.24	71.70	4.54	3.46	4.00	4.80	1:4.88

Apple-pomace, . . . . .	2	21.78	17.22	19.50	7.73	6.94	7.94	4.37	3.17	8.78	72.03	70.2	72.56	16.58	13.15	14.86	1.46	-
Apple-pomace ensilage, . . . . .	1	-	-	14.67	-	-	8.22	-	-	7.36	-	-	58.03	-	-	22.18	4.21	-
Sugar-beet pulp, from diffusion battery, . . . . .	1	-	-	10.32	-	-	12.41	-	-	.95	-	-	61.86	-	-	23.74	1.04	-
Corn cobs, . . . . .	4	-	-	90.00	4.15	3.00	3.57	.67	.38	.57	63.62	60.58	61.78	33.77	31.36	32.93	1.21	1:30.85
Palmetto root, . . . . .	1	-	-	88.49	-	-	3.82	-	-	.53	-	-	69.85	-	-	21.28	4.44	-

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## B. Analyses of Fodder Articles, with Reference to Fertilizing Ingredients.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphate Acid.	Insoluble Matter.	Valuation per
												Ton of 2,000 Pounds.
I. Green Fodders.												
Corn fodder, . . . . .	4	72.64	.564	1.64	.620	.102	.312	.132	.042	.281	.703	\$2 78
Corn fodder, ensilage, . . . . .	1	71.60	.360	1.32	.330	.050	.100	.090	.020	.140	.040	1 68
White kibi, . . . . .	2	76.45	.468	1.22	.200	.045	.232	.148	.019	.136	.652	2 09
Mochi millet, . . . . .	3	62.58	.609	2.62	.407	.120	.201	.217	.021	.166	.708	2 65
Mix, . . . . .	3	75.59	.468	1.54	.383	.060	.249	.245	.021	.237	.527	2 38
Green oats, . . . . .	3	83.36	.468	1.31	.381	.217	.154	.134	.018	.130	.496	2 14
Vetch and oats, . . . . .	1	80.11	.238	1.72	.766	.031	.087	.030	.012	.064	.331	1 58
Horse bean, . . . . .	1	74.71	.675	1.45	1.370	.090	1.370	.620	.200	.330	2.040	3 87
Cow-pea vines, . . . . .	1	78.81	.274	1.47	.306	.063	.300	.099	.016	.068	.077	1 51
Serradella, . . . . .	2	82.59	.411	1.82	.420	.097	.460	.067	.021	.140	.097	1 92
White lupine, . . . . .	1	85.35	.440	.74	1.730	.680	3.070	.730	.170	.360	.900	3 39
Spanish moss ( <i>Tillandsia</i> ), . . . . .	1	60.80	.278	1.04	.255	.263	.089	.122	.029	.030	.191	1 20

Perennial rye-grass, .	.	.	.	.	.	2	9.13	1.227	6.79	1.553	.307	.842	.337	.044	.559	2.262	6 16
Italian rye grass, .	.	.	.	.	.	2	8.29	1.150	6.89	.992	.595	1.072	.306	.098	.552	2.899	5 41
Salt hay, . . . . .	.	.	.	.	.	1	5.36	1.180	-	.718	.017	.371	.335	.028	.848	-	4 92
Corn fodder, . . . . .	.	.	.	.	.	4	-	1.800	4.91	.760	.010	.600	.690	.070	.510	1.650	7 38
Corn stover, . . . . .	.	.	.	.	.	2	28.24	1.118	3.74	1.320	.794	.524	.257	.056	.303	.811	5 28
Teosinte, . . . . .	.	.	.	.	.	1	6.06	1.480	6.53	3.698	.109	1.597	.458	.021	.545	.315	8 72
Yammoth red clover, .	.	.	.	.	.	3	11.41	2.931	8.72	1.923	.389	3.141	.613	.111	.546	.779	9 38
Medium red clover, . .	.	.	.	.	.	1	10.72	2.088	8.36	2.901	.192	1.838	.402	.061	.436	.254	9 49
Alfalfa clover, . . . . .	.	.	.	.	.	5	9.93	2.331	11.11	2.008	.317	2.209	.537	.216	.703	1.746	10 46
Lucerne ( <i>alfalfa</i> ), . . .	.	.	.	.	.	4	6.26	2.075	6.82	1.481	.814	2.211	.406	.078	.526	.513	8 92
Bokhara clover, . . . . .	.	.	.	.	.	1	6.36	1.770	6.46	1.673	.077	1.938	.373	.025	.438	.013	7 96
Blue melilot, . . . . .	.	.	.	.	.	1	8.22	1.919	13.65	2.796	.270	1.449	.260	.349	.544	4.008	9 55
Sulla, . . . . .	.	.	.	.	.	1	10.46	2.441	7.85	1.872	.362	2.791	.378	.147	.694	.987	10 40
Lotus villosus, . . . . .	.	.	.	.	.	1	12.36	2.259	7.32	1.550	.633	2.861	.615	.148	.500	1.053	9 50
Soja bean, . . . . .	.	.	.	.	.	2	6.30	2.320	6.47	1.079	.148	2.760	1.178	.115	.687	.977	9 54
Cow-pea, . . . . .	.	.	.	.	.	1	9.00	1.635	8.40	.913	.122	2.696	.688	.046	.527	.832	6 96
Serradella, . . . . .	.	.	.	.	.	2	7.39	2.637	10.60	.652	.656	2.545	.461	.066	.777	.590	10 64
Vetch and onts, . . . . .	.	.	.	.	.	2	11.98	1.368	10.96	.903	.199	.539	.253	.137	.525	.212	6 05

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## B. Analyses of Fodder Articles, with Reference to Fertilizing Ingredients — Concluded.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per Ton of 2,000 Pounds.
II. Hay and Dry Coarse Fodders — Concluded.												
White daisy, . . . . .	1	9.65	.279	6.37	1.253	.164	1.302	.191	.032	.435	1.110	\$2 54
Dry carrot tops, . . . . .	1	9.76	3.130	12.52	4.883	4.028	2.080	.667	.118	.812	.098	15 52
III. Roots, Bulbs, Tubers, etc.												
Beets, red, . . . . .	7	87.73	.243	1.13	.438	.091	.049	.033	.004	.091	.020	1 31
Beets, sugar, . . . . .	2	84.65	.250	.80	.285	.151	.056	.037	.018	.083	.006	1 19
Beets, yellow fodder, . . . . .	1	90.60	.192	.96	.462	.104	.045	.030	.005	.006	.015	1 14
Mangolds, . . . . .	2	87.29	.188	1.22	.383	.125	.061	.039	.005	.093	.023	1 06
Ruta-bagas, . . . . .	2	87.82	.210	1.10	.500	.100	.090	.030	.003	.131	.010	1 30
Turnips, . . . . .	1	87.20	.221	1.01	.412	.133	.117	.033	.009	.116	.072	1 22
Carrots, . . . . .	1	90.02	.140	.88	.540	.110	.070	.020	.010	.100	.010	1 06
Potatoes, . . . . .	1	79.75	.207	.99	.294	.013	.007	.020	.002	.006	.006	1 03
Apples, . . . . .	2	79.91	.130	.41	.180	.030	.030	.030	.003	.010	.003	.49
IV. Grains and Other Seeds.												
Corn kernels, . . . . .	13	10.88	1.922	1.53	.404	.034	.032	.206	.019	.599	.020	6 37

## Y. L. By-products and Residue.

Wheat flour, . . . . .	1	9.83	2.21	1.22	.640	-	.170	.050	-	.570	-	8 65
Pea meal, . . . . .	1	8.85	3.06	2.68	.893	.618	.302	.302	.027	.820	.122	11 31
<hr/>												
Linseed cake, old process, . . . . .	3	7.79	6.021	7.13	1.162	-	.656	.799	.060	1.646	.355	23 44
Linseed cake, new process, . . . . .	2	6.12	5.366	5.33	1.160	-	.552	.534	.047	1.420	.152	21 02
Cotton-seed meal, . . . . .	6	8.36	6.41	6.27	1.620	.190	.710	1.100	.190	2.080	.501	25 68
Wheat bran, . . . . .	4	11.01	2.86	6.44	1.620	.180	.200	.900	.090	2.870	.130	14 77
Wheat middlings, . . . . .	1	9.18	2.63	2.30	.630	.110	.200	.210	-	.950	-	10 63
Rye middlings, . . . . .	3	12.54	1.84	3.52	.810	.030	.090	.320	.020	1.260	.170	8 46
Gluten meal, . . . . .	4	8.53	5.46	.65	.045	.018	.050	.085	.069	.425	-	19 01
Spent brewer's grain, . . . . .	1	6.98	3.05	6.15	1.550	.347	.296	.286	.159	1.260	1.770	12 14
Cocoa dust, . . . . .	1	7.10	2.299	6.35	.630	-	.630	-	-	1.340	-	11 22
Broom-corn waste (stalks), . . . . .	1	10.37	.870	4.70	1.853	-	.242	.170	-	.460	1.000	5 09
Cotton hulls, . . . . .	3	10.63	.750	2.61	1.080	-	.200	.260	-	.180	.060	3 74
Apple pomace, . . . . .	2	80.50	.227	.271	.134	.026	.037	.028	.008	.018	.009	90
Corn cobs, . . . . .	8	12.09	.504	.815	.568	.071	.025	.045	.009	.063	.190	2 44
Palmetto root, . . . . .	1	11.51	.640	3.93	1.380	.345	.045	.004	.017	.157	.410	3 20

NOTE. — Basis of valuation, nitrogen, 17 cents; phosphoric acid, 6 cents; potassium oxide, 4½ cents per pound.

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*C. Analyses of Fruits.*

NAME.	Date.	Dry Matter.	Specific Gravity of Juice.	Temperature C. of Juice (Degrees).	Total Sugar in Juice.	Grape Sugar in Juice.	Cane Sugar in Juice.
	<b>1877.</b>	Per ct.			Per ct.	Per ct.	Per ct.
Apple (Baldwin), . . .	Sept. 1,	20.14	1.055	12—15	3.09	-	-
Apple (Baldwin), . . .	Oct. 9,	19.66	1.065	12—15	6.25	-	-
Apple (Baldwin), . . .	Nov. 27,	-	1.075	12—15	10.42	-	-
Rhode Island Greening, . . .	Sept. 1,	20.27	1.055	12—15	3.16	-	-
Rhode Island Greening, . . .	Oct. 9,	19.69	1.066	12—15	7.14	-	-
Rhode Island Greening,† . . .	Nov. 27,	20.25	1.080	12—15	11.36	-	-
Pear (Bartlett), . . .	Aug. 31,	15.00	1.060	12—15	4.77	-	-
Pear (Bartlett), . . .	Sept. 7,	16.55	1.060	12—15	5.68	-	-
Pear (Bartlett), . . .	Sept. 20,	-	1.065	12—15	8.62	-	-
Pear (Bartlett),† . . .	Sept. 22,	-	1.060	12—15	8.93	-	-
Cranberries, . . .	-	10.71	1.025	15	1.35	-	-
Cranberries, . . .	1878.	10.11	1.025	15	1.70	-	-
Early York Peach (ripe), . . .	-	-	1.045	25	-	1.92	6.09
Early York Peach (nearly ripe), . . .	-	10.96¶	1.039	25	-	1.36	4.12
Crawford Peach (nearly ripe), . . .	-	-	1.050	18	-	2.19	7.02
Crawford Peach (mellow), . . .	-	11.36¶	1.055	18	-	1.70	8.94
Crawford Peach (not mellow), . . .	-	11.88¶	1.045	22	-	1.67	5.92

\* One part Na<sub>2</sub> CO<sub>3</sub> in 100 parts of water.

† Picked October 9.

‡ Picked September 7.

§ Free acid, 2.25 per cent.

|| Free acid, 2.43 per cent.

¶ In pulp, kept ten days before test.

*C. Analyses of Fruits—Continued.*

[Wild and cultivated grapes.]

NAME.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter.	Grape Sugar in Juice.	Sugar in Dry Matter.	* Soda Sol. requir- ed to neutralize 100 parts Juice.
	<b>1876.</b>			Per ct.	Per ct.	Per ct.	C. G.
. . . .	July 17,	1.0175	31	8.30	.645	7.77	-
. . . .	July 20,	1.0150	31	8.10	.625	7.72	216
. . . .	Aug. 2,	1.0200	25	9.94	.938	9.44	249
. . . .	Aug. 16,	1.0250	28	10.88	2.000	18.38	229
. . . .	Aug. 30,	1.0500	25	15.58	8.620	55.33	120
. . . .	Sept. 13,	1.0670	23	17.48	13.890	79.46	55
. . . .	Sept. 4,	1.0700	18	19.82	16.130	81.38	49.2
e, . . . .	July 19,	1.020	31	9.00	.714	7.93	204
e, . . . .	Aug. 4,	1.020	28	12.25	1.100	8.98	246
e, . . . .	Aug. 16,	1.025	28	12.48	2.000	16.03	233
e, . . . .	Aug. 30,	1.050	26	16.58	6.500	39.81	147.6
. . . .	Aug. 31,	1.050	26	16.48	9.260	56.18	98
. . . .	Sept. 5,	1.060	22	17.39	13.89	79.87	88.8
. . . .	Sept. 6,	1.070	26	20.15	15.15	75.14	88.6
. . . .	Sept. 7,	1.080	21	24.56	15.15	61.68	144
. . . .	Sept. 7,	1.045	26	15.41	6.25	40.56	204.4
. . . .	Sept. 11,	1.075	20	20.79	17.24	82.92	94.8
. . . .	Sept. 11,	1.064	20	16.53	13.67	82.69	56
. . . .	Sept. 12,	1.080	24	23.47	17.86	76.09	74
. . . .	Sept. 12,	1.080	24	15.98	8.77	54.94	168.3
. . . .	Sept. 16,	1.075	23	19.67	9.20	46.77	89.8
. . . .	Sept. 20,	1.080	21	20.65	16.13	78.11	181.8
. . . .	Sept. 20,	1.065	21	15.11	13.17	87.16	68
. . . .	Oct. 16,	1.080	13	23.45	17.39	74.16	82
	<b>1877.</b>						
. . . .	Sept. 11,	1.065	23	16.41	15.15	92.32	60
. . . .	Sept. 12,	1.055	23	16.22	9.80	60.42	96
. . . .	Sept. 13,	1.065	24	15.90	13.16	82.76	102
. . . .	Sept. 26,	1.075	24	19.34	15.43	79.78	70.8
. . . .	Sept. 24,	1.065	16	19.62	13.16	67.07	73
e, . . . .	Sept. 5,	1.050	22	15.57	7.20	46.24	140.8
e (shrivelled), .	Sept. 20,	1.060	16	20.02	10.00	49.95	130
e (shrivelled), .	Sept. 20,	1.045	16	16.69	8.22	49.25	104

\* One part of pure  $\text{Na}_2\text{CO}_3$  in 100 parts water.

*C. Analyses of Fruits — Continued.*

[Effect of girdling on grapes.]

NAME AND CONDITION.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter at 100° C.	Grape Sugar in Juice.	Sugar in Dry Matter.
	<b>1877.</b>			Per ct.	Per ct.	Per ct.
Hartford Prolific, not girdled, . . .	Sept. 3,	1.045	19	12.85	8.77	68.25
Hartford Prolific, girdled, . . .	Sept. 3,	1.065	19	17.18	12.50	72.76
Wilder, not girdled, . . .	Sept. 3,	1.055	19	15.41	10.42	67.62
Wilder, girdled, . . .	Sept. 3,	1.075	19	17.24	14.70	85.26
Delaware, not girdled, . . .	Sept. 4,	1.065	19	15.75	11.76	74.66
Delaware, girdled, . . .	Sept. 4,	1.075	19	19.14	15.15	79.16
Agawam, not girdled, . . .	Sept. 4,	1.060	19	16.60	11.37	68.48
Agawam, girdled, . . .	Sept. 4,	1.075	19	18.45	16.31	87.42
Iona, not girdled, . . .	Sept. 6,	1.0625	22	16.60	13.51	68.31
Iona, girdled, . . .	Sept. 6,	1.085	22	21.48	15.63	72.76
Concord, not girdled, . . .	Sept. 6,	1.045	22	13.46	7.46	55.42
Concord, girdled, . . .	Sept. 6,	1.070	22	17.53	13.88	79.18
Concord, not girdled, . . .	Sept. 26,	1.065	22	17.63	13.70	78.27
Concord, girdled, . . .	Sept. 26,	1.080	22	24.47	19.61	80.13
Concord, not girdled, . . .	Oct. 5,	1.075	12	20.92	17.50	85.37
Concord, girdled, . . .	Oct. 5,	1.085	12	-	17.86	-
		100 PARTS OF GRAPES CON- TAINED —				
	Date.	Ash.	Moisture.	Grape Sugar.		
	<b>1889.</b>					
Concord, not girdled, . . .	Sept. 23,	-	84.69	6.24		
Concord, girdled, . . .	Sept. 23,	.42	83.00	8.13		
Concord, not girdled, . . .	Oct. 8,	.53	84.51	6.09		
Concord, girdled, . . .	Oct. 8,	.37	82.69	8.50		

\* One part Na<sub>2</sub> CO<sub>3</sub> to 100 parts of water.

*C. Analyses of Fruits — Continued.*

of fertilization upon the organic constituents of wild grapes.]

NAME.	Date.	Dry Matter.	Specific Gravity.	Temperature C. (Degrees).	Per Cent. of Grape Sugar.	Per Cent. of Acids.	Remarks.
	<b>1877.</b>						
pe Berries, .	Sept. 20,	16.31	-	-	8.03	-	Unfertilized.
pe Berries, .	"	19.55	-	-	13.51	-	Fertilized.
pe Juice, . .	"	-	1.045	16	8.22	9.840	Unfertilized.
pe Juice, . .	"	-	1.065	16	13.51	1.149	Fertilized.
pe Berries, .	"	20.02	-	-	-	-	Unfertilized.
pe Berries, .	"	21.65	-	-	-	-	Fertilized.
pe Juice, . .	"	-	1.060	16	10.00	1.846	Unfertilized.
pe Juice, . .	"	-	-	-	14.29	.923	Fertilized.

fect of fertilization upon the ash constituents of grapes.]

	Date.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Remarks.
	<b>1876.</b>								
es,	Sept. 13,	50.93	.15	22.23	5.59	.79	17.40	2.93	Unfertilized.
es,	Sept. 20,	62.65	.85	14.24	3.92	.53	13.18	4.63	Fertilized.
.	July 7,	41.73	5.04	25.03	7.80	.55	18.48	1.37	Unfertilized.
.	July 17,	47.24	1.13	24.21	-	.75	21.38	.43	Unfertilized.
.	Aug. 18,	51.14	3.19	16.20	6.38	.65	20.77	1.67	Unfertilized.
.	Sept. 13,	57.15	4.17	11.30	3.10	.40	12.47	11.82	Unfertilized.
	<b>1878.</b>								
.	Oct. 3,	64.65	1.42	9.13	3.63	.50	14.87	5.80	Fertilized.



## 306 AGRICULTURAL EXPERIMENT STATION.

*C. Analyses of Fruits—Concluded.*

[Ash analyses of fruits and garden crops.]

NAME.	Ash.	100 PARTS OF ASH CONTAINED—					
		Potash.	Soda.	Lime.	Magnesia.	Ferrie Oxide.	Phosphoric Acid.
Concord Grape (fruit), . . .	-	51.14	3.19	16.20	6.38	.65	20.7
Unfermented juice, . . .	-	50.85	.48	3.69	4.25	.10	6.4
Fermented juice, . . .	-	40.69	-	6.85	6.24	-	9.0
Skins and pulp, . . .	-	7.70	.42	57.36	8.80	.08	24.4
Seeds, . . . . .	3.08	6.71	-	-	3.03	-	17.5
Stems of grapes, . . .	4.69	20.91	-	20.20	8.45	-	17.7
Young branches, * . . .	-	24.71	.94	40.53	10.66	1.08	17.3
Wood of vine, † . . .	2.97	22.57	-	9.72	4.28	-	14.0
Clinton Grape (fruit), . . .	-	58.45	3.51	13.34	7.37	.90	18.1
Baldwin Apple, . . . . .	-	63.54	1.71	7.28	5.52	1.08	20.8
Strawberry (fruit), ‡ . . .	.52	49.24	3.23	13.47	8.12	1.74	18.5
Strawberry (fruit), § . . .	-	58.47	-	14.64	6.12	3.37	17.4
Strawberry vines, . . . .	3.34	10.62	13.35	36.63	3.83	6.91	14.4
Cranberry (fruit), . . . .	.18	47.96	6.58	18.58	6.78	-	14.2
Cranberry vines, . . . . .	2.45	12.98	3.27	16.49	10.33	3.35	10.9
Currants, red, . . . . .	.47	47.68	4.02	18.96	6.23	1.20	21.9
Currants, white, . . . . .	.59	52.79	3.00	17.08	5.68	2.67	18.7
Crawford Peach, sound, . . .	-	74.46	-	2.64	6.29	.58	16.0
Crawford Peach, diseased,    .	-	71.30	-	4.68	5.49	.46	16.0
Branch, sound, . . . .	-	26.01	-	54.52	7.58	.52	11.3
Branch, diseased,    . . .	-	15.67	-	64.23	10.28	1.45	8.3
Asparagus stems, . . . . .	-	42.94	3.58	27.18	12.77	1.22	12.3
Asparagus roots, . . . . .	-	56.43	5.42	15.48	7.57	-	15.0
Onions, . . . . .	-	38.51	1.90	8.20	3.65	.58	15.8

\* With tendrils and blossoms. † One year old. ‡ Wilder. § Downing. || Young.

*D. Analyses of Sugar-producing Plants.*

of sugar beets raised upon the college grounds during the season of 1870 and 1871.]

NAME.	Date.	Brix Saccharom- eter (Degrees).	Per Cent. of Sugar.	Non- saccharine Substances.
. . . . .	Sept. 10,	14	12.30	1.75
. . . . .	" 12,	15	12.59	2.41
. . . . .	" 13,	14.5	12.95	1.55
. . . . .	" 18,	14	10.79	3.21
. . . . .	Oct. 11,	15	12.05	2.95
. . . . .	" 16,	15	12.22	2.78
. . . . .	" 18,	16	13.13	2.87
. . . . .	Nov. 14,	15	11.60	3.34
. . . . .	" 21,	15.5	13.12	2.38
*, . . . .	Sept. 19,	11	8.00	3.00
gold,*, . . .	" 19,	9	5.00	3.97

\* Fodder beets.

of sugar in different varieties of sugar beets grown on college farm during the season of 1882.]

NAME.	Source of Seed.	Weight in Pounds.	Per Cent. of Sugar in Juice.
. . . . .	Saxony, .	$\frac{3}{4}$ to $\frac{7}{8}$	15.50
. . . . .	Saxony, .	$\frac{3}{4}$ to 1	15.61
berial, . . . .	Saxony, .	$\frac{3}{4}$ to $1\frac{1}{4}$	14.20
berial, . . . .	Saxony, .	$1\frac{1}{4}$ to 2	10.27
, . . . .	Saxony, .	$1\frac{1}{4}$ to $1\frac{3}{4}$	13.80
gdeburg, . . .	Saxony, .	$1\frac{1}{2}$ to 2	13.10
gdeburg, . . .	Silesia, .	$1\frac{1}{2}$ to $1\frac{3}{4}$	10.06
. . . . .	Saxony, .	$1\frac{1}{2}$ to $1\frac{3}{4}$	13.44
n, . . . . .	Silesia, .	$1\frac{1}{2}$ to $1\frac{3}{4}$	9.72

# 308 AGRICULTURAL EXPERIMENT STATION

## D. Analyses of Sugar-producing Plants—Continued

[Effect of soil and fertilization on Electoral sugar beets.\*]

SOIL.	MANURE.	Specific Gravity Juice (Degrees).	Per Cent. of Sugar in Juice.	Non-saccharine
Sandy loam, .	Fresh yard-manure, .	16.5	12.50	4.1
Clayish loam, .	Fresh yard-manure, .	15.5	11.05	4.1
Warm alluvial, .	Yard-manure and chemicals, . . .	12.75	9.17	3.8
Warm alluvial, .	Fresh hog-manure, .	13.5	9.53	3.8
Light, sandy soil, .	No manure, . . .	18.5	13.73	4.1
Alluvial soil, .	Brighton fish, . .	14.5	11.15	3.3
Heavy soil, .	Yard-manure, . .	12.25	8.15	4.1
-	-	13.5	9.90	3.6

\* Not raised on college farm (Connecticut valley).

[Effect of fertilization on sugar beets.\*]

FERTILIZERS.	PERCENTAGES OF SUGAR IN .		
	Freeport.	Electoral.	V.
Fresh horse-manure, . . . .	11.96	9.42	
Blood guano without potash, . . .	10.99	10.10	
Blood guano with potash, . . . .	12.55	13.24	
Kainite and superphosphate, . . .	13.15	12.16	
Sulphate of potash, . . . .	14.52	14.32	
Second year after stable-manure, . .	13.49	12.78	

\* All were grown on the same soil, — sandy loam (college).

*Analyses of Sugar-producing Plants — Continued.*

[Effect of different modes of cultivation on Electoral sugar beets.]

LOCALITY OF BEET-FIELD.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Cane Sugar.	Non-saccharine Substances.
Long, N. Y., . . .	1872-73	11	7.80	3.20
Longton, N. Y., . . .	"	14	10.97	3.03
Hartford, N. Y., . . .	"	15	11.70	3.30
Rich, N. Y., . . .	"	12	9.50	2.50
Port, N. Y., . . .	"	13.5	11.00	2.50
N. Y.,* . . .	"	18	15.10	2.90
N. Y.,† . . .	"	14	9.70	4.30

[Beets weighing from 1½ to 2 lbs. † From beets weighing from 10 to 14 lbs.]

loam resting on clayish hard-pan, had been for several years. Tomatoes had been the preceding crop. Five hundred pounds of phosphatic blood guano were applied before planting. The soil, a clayish loam, had been ploughed seven inches deep. A quantity of rotten sheep-manure was placed in trenches and the furrows running two furrows together, thus forming a ridge on which the seed were planted.

gravelly loam, which had been richly manured with stable manure and twice ploughed before planting.

sandy loam, underlaid by fine sand. The seed were planted in trenches which covered trenches containing a little rotten stable-

manure. Details of modes of cultivation received.

dark, reddish-brown, rich, deep, sandy loam. Clover had been for two years previous to a crop of carrots, which preceded the beets. The beets were the second crop after the application of manure and stable-manure per acre.

*Composition of Canada-grown Sugar Beets.*

[1872 and 1873.]

WHERE GROWN.	Weight of Roots.	Specific Gravity of Juice (Brix).	Temperature of Juice.	Per Cent. of Cane Sugar in Juice.
Montreal, . . .	2 to 2½ lbs.	15.4°	64° F.	11.38
Longton, . . .	2 to 3½ lbs.	14.5°	63° F.	10.20
Rich, . . .	2 to 2½ lbs.	13.2°	63° F.	9.02
Port, . . .	2 to 3 lbs.	13.4°	63° F.	8.83

## 310 AGRICULTURAL EXPERIMENT STATION

## D. Analyses of Sugar-producing Plants—Continued

[Early Amber Cane.]

DATE.	CONDITION OF CANE.	Brix Saccharometer (Degrees).	Temperature C. (Degrees).	Grape Sugar.	Cane Sugar.	Soda Solution re-
1879.						
Aug. 15.	No flower stalks in sight,*	4.2	27	Per ct.	Per ct.	C
Aug. 16.	No flower stalks in sight,*	5.8	24	2.48	None	
Aug. 20.	Flower stalks developed,*	7.9	24	4.06	None	
Aug. 24.	Flowers open,*	8.7	23	3.47	2.15	
Aug. 27.	Plants in full bloom,*	10.0	25	3.70	3.00	
Aug. 30.	Seed forming,*	9.5	30	3.65	4.13	1
Sept. 2.	Seed in milk,*	10.7	27	4.00	3.81	
Sept. 9.	Seeds still soft,*	12.1	22	3.85	4.41	
Sept. 9.	Stripped on Sept. 2,*	12.8	22	3.21	6.86	
Sept. 18.	Left on field without stripping,*	13.2	22	3.77	6.81	
Sept. 18.	Tops removed,*	13.8	22	3.57	7.65	
Sept. 18.	Tops and leaves removed on Sept. 9,*	11.5	22	3.16	8.49	
Sept. 18.	Tops removed; left on field 9 days,*	12.8	22	3.16	5.85	
Sept. 21.	Juice from the above,*	13.0	21	10.00	.60	
Sept. 23.	Juice from the above,*	15.0	18	-	-	
Sept. 25.	Left on field 3 weeks,†	19.8	21	11.91	6.27	
Sept. 25.	Left on field 3 weeks,†	17.8	12	16.60	-	
Oct. 4.	Left on field 3 weeks,†	16.1	17	8.62	6.16	1
Oct. 7.	Freshly cut. Ground with leaves,†	16.7	20	4.16	9.94	
Oct. 8.	Freshly cut. Stripped 2 weeks,†	12.8	17	5.16	5.27	
Oct. 9.	Freshly cut. Stripped 2 weeks,†	18.4	17	7.57	-	1
Oct. 14.	Several weeks old,†	18.2	15	10.42	-	1
Oct. 18.	Several weeks old,†	15.1	23	7.57	-	
Oct. 19.	Several weeks old,†	15.5	15	9.22	-	1
Oct. 22.	Several weeks old,†	16.2	16	8.30	-	
Oct. 23.	Several weeks old,†	18.3	17	11.30	5.5	1
Oct. 24.	Several weeks old,†	16.6	15	8.63	-	
		100 PARTS OF CANE CONTAINING				
		Moisture.	Grape Sugar.	Cane Sugar.	Total	
1889.						
October.	Early Tennessee sorghum, mature, .	77.43	1.79	3.21	5	
October.	Price's new hybrid, ripe, .	77.80	2.92	3.78	6	
October.	Kansas orange, green, .	80.67	2.38	3.63	6	
October.	New orange, green, .	78.30	2.96	3.85	6	
October.	Honduras, green, .	77.55	3.08	4.01	7	

\* Raised on the college farm.

† Raised by farmers in the vicinity of the

*Analyses of Sugar-producing Plants—Concluded.*

[Composition of the juice of corn stalks and melons.]

VARIETY.	Specific Gravity.	Temperature C. (Degrees).	Grape Sugar in Juice.	Cane Sugar in Juice.	Solids.
corn, *	1.023	27	Per ct. 4.35	Per ct. .28	Per ct. 15.18
can sweet corn, †	1.048	27	2.06	7.02	17.44
sweet corn, †	1.052	—	4.85	5.70	20.38
sweet corn, ‡	1.035	—	6.60	None.	—
yellow musk-melon, §	1.040	26	1.67	2.65	—
water-melon, .	1.025	18	2.91	2.16	—
water-melon, .	1.025	22	3.57	2.18	—
water-melon, .	1.025	19	3.84	1.77	—
musk-melon,	1.030	19	3.33	2.11	—
musk-melon, ¶	1.050	20	2.27	5.38	—
musk-melon, **	1.030	19	2.50	1.43	—

\* Tassels appearing.

† Ears ready for the table.

‡ Kernels somewhat hard.

§ Fully ripe.

|| Not ripe.

¶ Ripe.

\*\* Over-ripe.

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*E. Analyses of Dairy Products.*

	Analyses.	Solids.			Fat.			Curd.			Salt.			Ash.
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	
Whole milk, . . . . .	50	16.70	11.66	13.60	5.45	2.48	3.95	-	-	3.20	-	-	-	.70
Skim-milk, . . . . .	-	-	-	10.19	-	-	.37	-	-	3.53	-	-	-	.80
Buttermilk, . . . . .	-	-	-	8.18	-	-	.21	-	-	2.79	-	-	-	.80
Cream, . . . . .	54	28.51	22.65	25.03	20.90	13.74	16.99	-	-	-	-	-	-	.62
Butter, . . . . .	24	92.89	87.05	89.17	89.05	81.43	83.98	.89	.51	.66	6.45	3.61	4.80	-
Whole-milk cheese (Jersey),*	1	-	-	62.94	-	-	37.32	-	-	22.13	-	-	-	3.39
Whole-milk cheese,* . . . . .	1	-	-	64.17	-	-	34.34	-	-	26.69	-	-	-	3.14
Cheese from milk skimmed after twelve hours' standing,* .	1	-	-	62.70	-	-	27.81	-	-	30.37	-	-	-	4.52
Cheese from milk skimmed after twenty-four hours' standing,*	1	-	-	57.76	-	-	23.42	-	-	31.89	-	-	-	2.35
Cheese from milk skimmed after thirty-six hours' standing,*	1	-	-	56.05	-	-	17.67	-	-	33.94	-	-	-	5.14
Cheese from milk skimmed after forty-eight hours' standing,*	1	-	-	54.59	-	-	15.77	-	-	34.94	-	-	-	3.88
Cheese from skim-milk, with addition of buttermilk,* . . .	1	-	-	51.62	-	-	18.35	-	-	29.63	-	-	-	4.64
Genuine oleomargarine cheese,* . . . . .	1	-	-	62.10	-	-	31.66	-	-	23.94	-	-	-	4.50

	Moist.	Sodium.	Calcium.	Magn.	Sodium.	Magn.	Insol.	Sent on for examination.		Salicylic acid: trace.
Rock salt of Petite Anse, La.,	.390	98.882	.782	.004	.003	—	—			
Rock salt of Neyba, San Domingo, W. I.,	.300	98.380	1.480	—	.090	.070	—			
Solar salt, Onondaga, N. Y.,	2.500	96.004	1.315	.092	.089	—	.070			
Solar salt, Hocking Valley, O.,	2.130	97.512	None.	.234	.089	—	—			
Solar salt, Saginaw Valley, Mich.,	3.344	95.813	3.16	.356	.140	—	—			
Solar salt from Kansas,	4.950	93.060	1.220	—	.240	.350	.180			
Solar salt, Lincoln County, Neb.,	1.200	98.130	.250	—	.080	.390	None.			
Common fine and boiled salt, Onondaga, N. Y.,	3.000	95.353	1.355	.155	.136	—	—			
Common fine and boiled salt, Portsmouth, Mich.,	6.752	90.682	.805	.974	.781	—	—			
Common fine and boiled salt, Mason City, O.,	3.470	95.789	—	.614	.041	—	—			
Dairy and table salt, Ashton's (English),	0.760	97.652	1.430	—	.060	—	.048			
Onondaga dairy salt,	0.700	97.892	1.263	—	.037	.026	.023			
Fine salt, Bulletin 26, I.,	3.280	95.091	1.487	.032	.075	—	.035			
Fine salt, Bulletin 26, II.,	4.591	94.012	1.177	.143	.049	—	.028			
Fine salt, Bulletin 26, III.,	4.616	94.236	.999	.071	.026	—	—			
Dairy salt, sent on from Amherst, Mass.,	0.145	98.520	1.009	.189	.065	—	—			
Ashton salt (sent on),	.760	97.650	1.430	—	.060	—	.050			
Onondaga factory-filled (sent on),	.600	98.280	.910	—	—	.030	.060			
Dairy salt, sent on from Amherst,	.505	98.202	.877	.168	.046	—	—			
Rock salt from Retsof salt mines,	2.600	95.940	.420	.330	.010	—	.700			

CASEY SCIENCE LIBRARY



## METEOROLOGY.

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1889.

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Our weather observations have been conducted on the same general plan as in previous years, being essentially the same as that recommended to voluntary observers of the United States Signal Service. Besides this, we have for the summer months forwarded to a signal officer at Cambridge, Mass., a weekly report of temperature, rainfall, sunshine, and their effects as observed on the growing crops in this vicinity. This report was for use of the England Meteorological Society and the United States Signal Service in preparing a weekly weather and climate bulletin.

The winter months of 1889 were exceptionally mild. The lowest temperature during that time was nine degrees below zero. Ice did not form thick enough to be cut until the latter part of February. There was no snow on the ground until the 20th of January. Sleighs were in use from that date until the last week in February; most of the time, however, there was hardly enough snow for good sleighing. A snow storm amounting to 4.5 inches, occurred on March 31 and April 1. This snow quickly disappeared.

On account of the warm and dry weather during the spring, the ground was prepared and planted sooner than usual. Heavy frosts occurred May 4 and May 11; the latter touched our more tender crops, but apparently did not affect corn or potatoes.

February, March and April were our driest months. Less than three inches of water fell during February and March. The rains of May were abundant and well distributed. During June, July and the first part of August, an unusually large number of rainy days interfered seriously with farm operations. Considerable damage was done in our vicinity to pastured hay and grain.

average temperature of July and August was lower than the average of the preceding years. The cool weather during those two months retarded the ripening of corn, and was evidently injurious to the crop, judging from the unusual prevalence of fungous diseases.

The first frost occurred September 23; the first snow-fall, November 27, and the first snow-storm, December 1. The snow, in the latter case, to an inch and a half of depth. The severest snow-storm, amounting to 6.5 inches of snow, occurred December 14. Both of these snows melted soon.

During the eight months of the year the prevailing wind was the north-east; during March, September and October, the prevailing direction was north-east; and during June, July and August, it was the south-east.

The total rainfall during the year amounted to 43.72 inches, slightly below the average. The number of days during which an appreciable quantity of water fell was 128. The greatest number occurring in one month was 15, in July; the next, 7, in August. The largest rainfall for one day was 8.35 inches, in July; the smallest, 1.45 inches, in February.

During the first seven months of the year there were fifty-four days during which the sky was more than seven-tenths overcast by clouds at each observation. During the last five months, when a more detailed system of taking the observations was used, sixty-six days were noticed "cloudy;" thirty-four cloudy days occurred in September. On twenty-four days during the first seven months, the sky was found to be four-tenths overcast at each observation. April had each but one "clear" day; during the last five months there were but twenty-four clear days.

The annual average temperature was 47.78 degrees, which was 1 degree above the average. The highest temperature of the year was 89.5 degrees, occurring May 9; the lowest, 9 degrees, occurring February 24. The maximum temperature was 94.5 degrees, on July 23; the minimum, — 21.5 degrees, January 23. The absolute range of temperature was 98.5 degrees, against 116 for 1888, 115.2 for 1887, and 117 for 1886.

GEORGE S. HARRIS LIBRARY

*D. Analyses of Sugar-producing Plants—Continued.*

[Effect of soil and fertilization on Electoral sugar beets.\*]

SOIL.	MANURE.	Specific Gravity Brix (Degrees).	Per Cent. of Sugar in Juice.	Non-saccharine Substances.	Cane Sugar in Soluble Matter.
Sandy loam, .	Fresh yard-manure, .	16.5	12.50	4.00	75.08
Clayish loam, .	Fresh yard-manure, .	15.5	11.05	4.45	71.30
Warm alluvial, .	Yard-manure and chemicals, . . .	12.75	9.17	3.58	71.92
Warm alluvial, .	Fresh hog-manure, .	13.5	9.53	3.97	70.06
Light, sandy soil,	No manure, . . .	18.5	13.73	4.77	74.21
Alluvial soil, .	Brighton fish, . .	14.5	11.15	3.35	76.90
Heavy soil, .	Yard-manure, . .	12.25	8.15	4.10	66.53
-	-	13.5	9.90	3.60	73.33

\* Not raised on college farm (Connecticut valley).

[Effect of fertilization on sugar beets.\*]

FERTILIZERS.	PERCENTAGES OF SUGAR IN JUICE.		
	Freeport.	Electoral.	Vilmorin.
Fresh horse-manure, . . . .	11.96	9.42	7.80
Blood guano without potash, . .	10.99	10.10	10.20
Blood guano with potash, . . .	12.55	13.24	10.50
Kainite and superphosphate, . .	13.15	12.16	10.50
Sulphate of potash, . . . .	14.52	14.32	12.78
Second year after stable-manure, .	13.49	12.78	12.19

\* All were grown on the same soil, — sandy loam (college).

*Analyses of Sugar-producing Plants—Continued.*

Effect of different modes of cultivation on Electoral sugar beets.]

LOCALITY OF BEET-FIELD.	Date.	Brix Saccharom- eter (Degrees).	Per Cent. of Cane Sugar.	Non- saccharine Substances.
Sing, N. Y., . . .	1872-73	11	7.80	3.20
ington, N. Y., . . .	"	14	10.97	3.03
a Hartford, N. Y., . . .	"	15	11.70	3.30
nwich, N. Y., . . .	"	12	9.50	2.50
kfort, N. Y., . . .	"	13.5	11.00	2.50
n, N. Y.,* . . .	"	18	15.10	2.90
n, N. Y.,† . . .	"	14	9.70	4.30

beets weighing from 1½ to 2 lbs. † From beets weighing from 10 to 14 lbs.

l, loam resting on clayish hard-pan, had been for several years  
Tomatoes had been the preceding crop. Five hundred  
of a phosphatic blood guano were applied before planting.

l, a clayish loam, had been ploughed seven inches deep. A  
amount of rotten sheep-manure was placed in trenches and  
by running two furrows together, thus forming a ridge on  
e seed were planted.

l, a gravelly loam, which had been richly manured with stable  
and twice ploughed before planting.

l, a sandy loam, underlaid by fine sand. The seed were planted  
s, which covered trenches containing a little rotten stable-

details of modes of cultivation received.

l, a dark, reddish-brown, rich, deep, sandy loam. Clover had  
ed for two years previous to a crop of carrots, which preceded  
beets. The beets were the second crop after the application  
loads of stable-manure per acre.

*Composition of Canada-grown Sugar Beets.*

[1872 and 1873.]

WHERE GROWN.	Weight of Roots.	Specific Gravity of Juice (Brix).	Tempera- ture of Juice.	Per Cent. of Cane Sugar in Juice.
de Montreal, . . .	2 to 2½ lbs.	15.4°	64° F.	11.38
u Loup, . . .	2 to 3½ lbs.	14.5°	63° F.	10.20
. . . . .	2 to 2½ lbs.	13.2°	63° F.	9.02
ge, . . . . .	2 to 3 lbs.	13.4°	63° F.	8.83

## 318 AGRICULTURAL EXPERIMENT STATION. [Ja

## RECORD

*Of the Average Temperature taken from Weather Records at Amherst Mass., for three consecutive months, during the summer and winter beginning with the year 1836.*

December, January, February.			June, July, August.		
		Degrees F.			Degrees F.
1836-37,	.	25.396	1837,	.	69.130
1837-38,	.	26.386	1838,	.	69.550
1838-39,	.	25.950	1839,	.	70.180
1839-40,	.	20.626	1840,	.	68.770
1840-41,	.	23.146	1841,	.	69.230
1841-42,	.	28.516	1842,	.	68.210
1842-43,	.	23.460	1843,	.	67.950
1843-44,	.	21.320	1844,	.	67.260
1844-45,	.	25.550	1845,	.	70.120
1845-46,	.	22.140	1846,	.	68.406
1846-47,	.	25.176	1847,	.	68.806
1847-48,	.	28.966	1848,	.	69.210
1848-49,	.	23.026	1849,	.	69.210
1849-50,	.	27.570	1850,	.	68.820
1850-51,	.	25.040	1851,	.	66.640
1851-52,	.	21.620	1852,	.	66.830
1852-53,	.	27.940	1853,	.	67.846
1853-54,	.	23.670	1854,	.	69.856
1854-55,	.	23.126	1855,	.	67.146
1855-56,	.	20.820	1856,	.	69.225
1856-57,	.	22.720	1857,	.	67.240
1857-58,	.	26.956	1858,	.	67.930
1858-59,	.	24.746	1859,	.	65.650
1859-60,	.	24.790	1860,	.	66.540
1860-61,	.	24.510	1861,	.	66.870
1861-62,	.	24.470	1862,	.	66.490
1862-63,	.	27.640	1863,	.	66.656
1863-64,	.	26.060	1864,	.	69.336
1864-65,	.	21.310	1865,	.	68.946
1865-66,	.	25.676	1866,	.	67.400
1866-67,	.	25.276	1867,	.	67.920

*Record of Temperature, etc. — Concluded.*

December, January, February.		June, July, August.	
	Degrees F.		Degrees F.
.	20.350	1868, .	69.700
.	26.290	1869, .	66.890
.	27.866	1870, .	71.700
.	26.666	1871, .	67.810
.	24.630	1872, .	70.790
.	21.350	1873, .	68.596
.	27.286	1874, .	66.306
.	21.180	1875, .	68.026
.	28.156	1876, .	71.780
.	23.510	1877, .	70.080
.	28.506	1878, .	68.896
.	24.290	1879, .	68.150
.	30.506	1880, .	69.286
.	21.856	1881, .	67.966
.	29.256	1882, .	69.866
.	24.220	1883, .	68.840
.	26.506	1884, .	68.960
.	22.630	1885, .	66.740
.	24.846	1886, .	66.100
.	22.146	1887, .	68.100
.	20.827	1888, .	67.893
.	27.170	1889, .	66.300

C. A. GOESSMANN,

*Director.*

JAMES P. LYNDE, *Treasurer, in account with MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.*

1889.	RECEIVED.	1889.		EXPENDED.	
		\$10,000 00			
	From State Treasurer, . . . . .			Transferred to Hatch funds, . . . . .	\$705 33
	Dr. C. A. Goessmann, director, receipts at station, . . . . .	991 75		Salaries, . . . . .	5,057 52
	Dr. C. A. Goessmann, director, fees for certificates of analysis of commercial fertilizers, . . . . .	1,530 00		Laboratory supplies, . . . . .	927 48
				Printing and postage, . . . . .	509 40
				Office expenses, . . . . .	126 53
				Farmer and labor, . . . . .	2,600 92
				Farm supplies, . . . . .	610 72
				Stock, . . . . .	363 52
				Feed, . . . . .	354 02
				Miscellaneous expenses, . . . . .	598 37
				Construction and repairs, . . . . .	464 64
				Expenses Board of Control, . . . . .	188 30
				Cash in bank, . . . . .	15 00
			\$12,521 75		\$12,521 75

Examined, compared with the vouchers, found correct and approved. WM. R. SESSIONS, *Auditor.*

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ASTORIA SCIENCE LIBRARY





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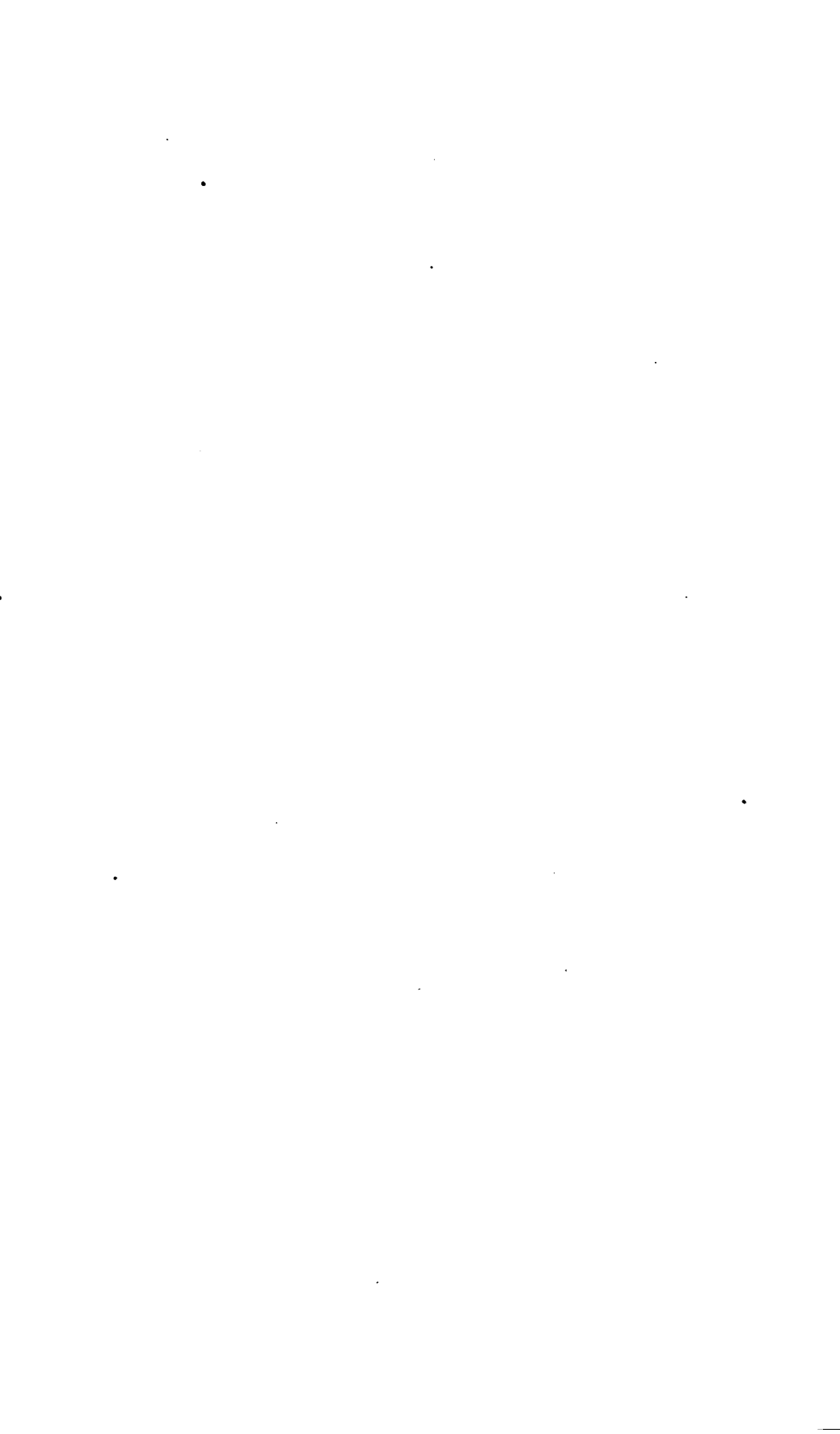
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See 1633.

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No. 33.

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EIGHTH ANNUAL REPORT

OF THE

BOARD OF CONTROL

OF THE

*Massachusetts*

STATE AGRICULTURAL EXPERIMENT  
STATION

AT

AMHERST, MASS.

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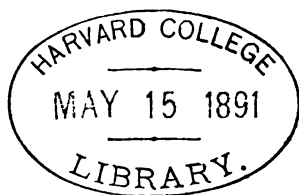
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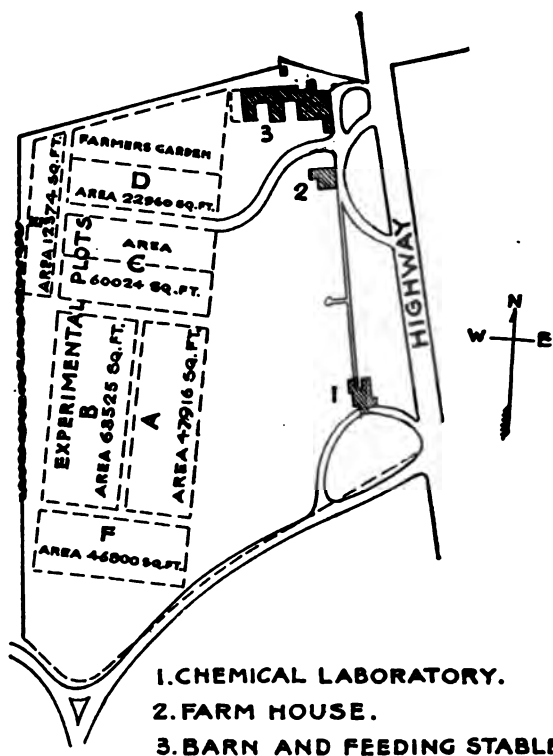
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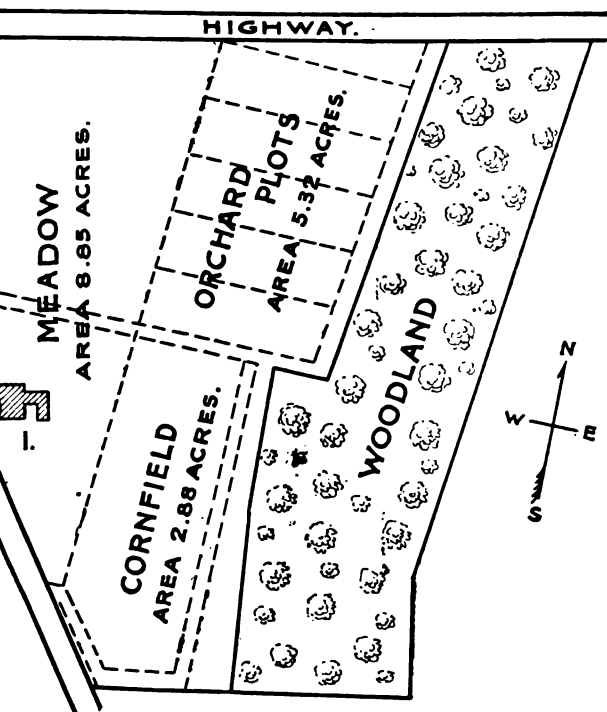
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Boston, Jan. 9, 1883.

*To the Honorable Senate and House of Representatives.*

In accordance with chapter 212 of the Acts of 1882 I have the honor to present the Eighth Annual Report of the Board of Control of the State Agricultural Experiment Station.

WM. R. SESSIONS,  
*Secretary.*

EIGHTH ANNUAL REPORT  
OF THE  
DIRECTOR OF THE MASSACHUSETTS STATE AGRICULTURAL  
EXPERIMENT STATION AT AMHERST, MASS.

---

*Honorable Board of Control.*

MEMORANDUM: — The present condition of the State Agricultural Experiment Station may be considered a satisfactory one so far as buildings and general outfit are concerned. The buildings are in a good state of repair, and the grounds are well equipped for the purpose they are to

The experimental work of the past year has been extended in various directions. A favorable season has largely assisted in a successful termination of the work in

Material changes have been made in regard to different lines of observation, decided upon at the beginning of the year. The details of the management have been carried out, as far as practicable, according to the plans from time to time presented for your consideration. Investigations in the laboratory, the vegetation house, the field and the barn, have received their due share of attention.

Professor Humphrey has continued his study of fungoid diseases of plants, in various directions. A detailed description of his work in that connection forms a chapter in the present report.

Series of field experiments, inaugurated at the close of the last season (1890), for the purpose of studying the effects of different forms of nitrogen and of phosphoric acid on the growth of winter rye and winter wheat, has been supplemented by control observations in pots in the vegetation

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## 10 AGRICULTURAL EXPERIMENT STATION. [J.]

A number of reputed fodder crops, more or less new to the soil of Massachusetts, have been studied with regard to their adaptation to our climate and soil. Some of them have been raised in sufficient quantity to test their service as green fodder or hay for milk production.

Feeding experiments with milch cows with reference to an economical production of milk, and with young pigs for remunerative production of pork, have been continued.

Considerable attention has been paid to the cost of the feed for the production of mutton and beef.

The work in the chemical laboratory has been, as usual, quite large, and for different purposes. The chemical analyses made at the station laboratory during the entire year, aside from four hundred analyses for the Hatch Station of the Agricultural College, number some nine hundred. Of these, from three hundred to four hundred were made at the special request of farmers in the State. They include analyses of fertilizers, fodder articles, well water, milk, &c.

The details of the work carried on in the directions previously stated are recorded in the subsequent pages of the annual report for 1890, under the following headings:—

### FEEDING EXPERIMENTS.

#### I. Two feeding experiments with milch cows.

1. Some general remarks on our previous feeding experiments with milch cows.
2. Feeding experiment with milch cows, to compare the value of old-process linseed meal with that of new-process linseed meal.
3. Feeding experiment with milch cows, to compare the economical value of reputed fodder crops,—vetch and oats, and soja bean,—when fed as green fodder in part or in whole for English hay.
4. Creamery record for 1889 and 1890.

II. Feeding experiments with lambs, to ascertain the cost of feed when fattening lambs, by means of winter fodder rations, and the meat market.

III. Feeding experiments with pigs,—skim-milk, corn meal, corn and cob meal, wheat bran and gluten meal, serving as food ingredients of the daily diet.

#### IV. Fodder analyses, 1890.

## FIELD EXPERIMENTS.

Some suggestions regarding the question, How can we live in an economical way the productiveness of our farm

Experiments to ascertain the effect of different combinations of nitrogen on oats.

Field experiments with prominent grasses and leguminous plants, to study their composition and general economical

I. Field experiments with reputed field and garden crops, to ascertain their adaptation to our soil and climate.

Field experiments to study the economy of using different commercial sources of phosphoric acid for manurial purposes in practice, — potatoes.

Experiments with grass land.

Report on general farm work.

II. Professor Humphrey's report.

## SPECIAL WORK IN THE CHEMICAL LABORATORY.

I. Analyses of licensed commercial fertilizers.

II. Miscellaneous analyses of material sent on for examination.

III. Water analyses.

IV. Compilation of fodder analyses, with reference to fodder constituents and fertilizing constituents; analyses of industrial products, garden crops, fruits, etc., made at Amherst, Mass.

V. Meteorological observations.

The periodical publications of the station have been as numerous as in previous years. The circulation of bulletins and annual reports is steadily increasing.

In closing, it becomes a pleasing duty to acknowledge the successful termination of the work carried on at the station during the past year is largely due to the industry and faithful execution of the various tasks assigned to all those associated with me for that purpose.

With the assurance of my sincere thanks for your kind attention, I permit me to sign,

Yours very respectfully,

C. A. GOESSMANN,

*Director of the Massachusetts Agricultural Experiment Station.*

## ON FEEDING EXPERIMENTS.

1890.

- 
- I. TWO FEEDING EXPERIMENTS WITH MILCH COWS.
  - II. ONE FEEDING EXPERIMENT WITH LAMBS.
  - III. TWO FEEDING EXPERIMENTS WITH PIGS.
  - IV. FODDER ANALYSES.

### I.

1. Some general remarks on our previous feeding experiments with milch cows. 2. Feeding experiments with milch cows, compare the value of old-process linseed meal with that of new-process linseed meal, when fed pound for pound under otherwise corresponding conditions. 3. Feeding experiments with milch cows, to compare the economical value of reputed fodder crops, vetch and oats, and soja bean, — when fed as green fodder in part or in whole as substitutes for English hay. 4. Creamery records for 1889 and 1890.

#### *1. Some General Remarks on our Previously Reported Feeding Experiments with Milch Cows.*

A careful examination of our last annual report cannot fail to show that our feeding experiments with milch cows previous to the close of 1889, were chiefly instituted for the purpose of securing a satisfactory answer to the following questions: —

- 1. What is the comparative feeding effect of dry fodder corn, of dry corn stover, and of a good corn ensilage, when used in part or in the whole as a substitute for English hay (upland meadow hay), in the daily diet of milch cows, and also that of a good root crop in place of corn ensilage; the amount and kind of grain feed remaining, for obvious reasons, the same under otherwise corresponding circumstances?

What is the *total cost*, as well as the *net cost*, of the feed per head in case of the different fodder combinations; making in all cases alike an allowance of a loss of twenty per cent. of the fertilizing constituents contained in the feed consumed, in consequence of the sale of the

What is the commercial value, at current market of the manurial refuse obtainable in the case of different combinations used as daily diet for the support of cows, making that eighty per cent. of the value of the fertilizing constituents contained in the fodder consumed can be secured on a farm by a careful management?

The results of these experiments, which extend over a period of five successive years, 1885-89, were summed up in the following statements:—

The high nutritive value of fodder corn, corn stover and corn ensilage, as compared with that of English hay, counting in all instances pound for pound of dry vegetable matter, is fully confirmed. The general condition of the animal on trial, as well as the quality and the quantity of milk obtained, point in that direction.

To produce one quart of milk, using the same quantity and quality of grain feed, required in every instance a smaller quantity of perfectly dried hay than of either fodder corn stover or corn ensilage, in a corresponding state of maturity, — corn stover leading.

The net cost of feed in the case of the same ration of grain feed is from one-third to one-half less per quart of milk when fodder corn, corn stover or corn ensilage serve as substitutes for English hay in the daily diet of milch cows. Fodder corn, as a rule, leading, while corn stover and corn ensilage in four out of six cases.

Sugar beets, as well as carrots, when fed pound for pound of dry matter in place of part of the hay ration, with the same kind and quantity of grain feed, have raised almost without an exception the temporary yield of milk; exceeding, as a rule, the corn ensilage in that direction.

Corn ensilage, as well as roots, proved best when fed in place of one-fourth to one-half of the full hay ration. From twenty-five to twenty-seven pounds of roots, or from

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thirty-five to forty pounds of corn ensilage per day, all the hay called for to satisfy the animal in either case seems, for various reasons, a good proportion, allowing the stated kind and quantity of grain feed.

6. The influence of the various diets used on the quality of the milk seems to depend in a controlling degree on the constitutional characteristics of the animal on trial. The effect is not unfrequently in our case the reverse in different animals depending on the same diet. The increase in the quantity of milk is frequently accompanied by a decrease in solids.

The valuation of the fodder ingredients is based in connection on the average of the local market price per bushel of each article for the entire period of observation : —

Corn meal, . . .	\$22 75	Fodder corn, . . .	\$
Wheat bran, . . .	21 00	Corn stover, . . .	
Gluten meal, . . .	24 50	Corn ensilage, . . .	
Hay, . . .	15 00	Carrots, . . .	
Rowen, . . .	15 00	Sugar beets, . . .	

The commercial valuation of the fertilizing constituents contained in each fodder article is based on the following market prices : *i. e.*, nitrogen (per pound), 17 cents ; phosphoric acid, 6 cents ; and potassium oxide, 4½ cents. Eight per cent. of the entire amount of fertilizing constituents contained in the fodder consumed is considered obtained by proper management, while twenty per cent. is assumed to be sold with the milk.

For further details, see seventh annual report of station, pages 37-47, and 73-84.

It will be apparent, from the above statements, that it was the main aim of our feeding experiments with milch cows during the years 1885-89, to compare the relative feeding value of our *current coarse fodder articles* with each other, as, English hay, rowen, fodder corn, corn stover, corn ensilage and roots. To do this judiciously required in all cases the use of the same quantity and quality of grain feed. It is for this reason chiefly that the latter was confined to the same quantity of corn meal, corn and cob meal, wheat bran and gluten meal.

These articles were at any time at our disposal in our market; all of them could claim a fair reputation for production.

During the past year *we have changed the object of our feeding experiments* with milch cows. Having made ourselves, as far as practicable, familiar with the feeding effect of our general economical value of our current *coarse home-grown fodder articles*, it was decided to compare the feeding effect of our prominent concentrated fodder articles (grains, oilcakes, gluten meal, starch feed, etc.) with each other, under otherwise corresponding circumstances. Some experiments with the two kinds of linseed meal (old and new process) are described within a few subsequent pages.

## 2. Feeding Experiments with Milch Cows.

Old-process linseed meal *vs.* new-process linseed meal, Dec. 1889–July 2, 1890.

The feeding experiments subsequently described were conducted chiefly for the purpose of comparing the effect of new-process linseed meal with that of old-process linseed meal, on the *quantity* and *quality* of milk produced, on the *cost of feed* consumed, when fed in *equal weights* as an ingredient of an otherwise corresponding daily diet for milch cows. This inquiry into the respective merits of the two kinds of linseed meal for dairy purposes has been undertaken in response to frequent inquiries regarding that point on the part of dairymen in our State. The old-process linseed meal is sold, in our local markets, at \$27 per ton of 2000 pounds, and the new-process linseed meal of the Cleveland Linseed Oil Company at \$26 for the same weight. The first-named article is obtained when the seed is subjected to the action of a powerful press to secure its oil; the latter is produced by the aid of a new process, patented by the Cleveland company. The new process favors a thorough abstraction of the oil, and involves, it is said, a boiling of the seeds. The difference in the treatment of the seed, for the separation of the oil, explains one of the most characteristic differences in the composition of the two kinds of linseed meal; for old-process linseed meal



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contains, as a rule, a larger percentage of oil or fat, and a smaller one of organic-nitrogen-containing matter, than the new-process linseed meal. Aside from the stated cause of differences in their composition, there are various other circumstances which not unfrequently contribute toward serious variations in the composition of individual samples of both kinds. Among these is most prominent a more or less advanced state of maturity of the plant when harvested. Our inquiry into the comparative value of both kinds of meal as a fodder ingredient of the daily diet for milch cows has been carried on with articles of the following average composition :—

COMPOSITION OF LINSEED MEAL USED.		New-process Linseed Meal.	Old-process Linseed Meal.
Moisture at 100° C.,		Per Cent. 5.06	Per Cent. 9.00
Dry matter,		94.94	90.00
<i>Analysis of Dry Matter.</i>		100.00	100.00
Crude ash,		6.34	7.00
“ cellulose,		8.93	8.00
“ fat,		2.17	7.00
“ protein (nitrogenous matter),		41.02	36.00
Non-nitrogenous extract matter,		41.54	39.00
		100.00	100.00

## *Fertilizing Constituents.*

	Per Cent.	Per Cent.
Moisture at 100° C.,	5.06	9.00
Nitrogen, .	6.25	5.00
Phosphoric acid, .	1.42	1.00
Potassium oxide, .	1.16	1.00
Valuation per ton of 2,000 pounds, .	\$24 00	\$21 00

cows, grades of various description, all of fair milk-  
qualities, were selected for the trial. Two had dropped  
at calves one month before the beginning of the  
trial, one five months, and two from eleven to twelve

They differed but one year in their respective ages,  
and were from six to seven years.

Sh hay, rowen, fodder corn, corn stover, corn ensi-  
lage and sugar beets furnished at different times the  
bulk of the daily fodder ration; while corn meal, wheat  
and both kinds of linseed meal alternately served as  
supplementary feed stuffs to secure a desired high nutritive  
value for the entire diet. The daily quantity of the  
feed, of roots and of hay, in case corn ensilage fur-  
nished largely the coarse feed, was in each case a definite  
quantity decided upon before; it was in each case entirely con-

The daily consumption of the coarse portion of the  
fodder combination on trial, as hay when fed  
to rowen, fodder corn, corn stover and corn ensilage,  
was decided on the appetite of each individual animal. It  
was usually somewhat in quantity in case of different  
animals. Care was taken to offer to each a liberal quantity.  
The consumed portion was weighed back each day,  
and consequently accounted for in the daily feeding

Fodder corn, corn ensilage and corn stover were  
all from the same variety of corn, "Pride of the  
North" dent corn. The ensilage corn and the fodder corn  
were at a corresponding stage of growth; i.e., with kernel  
beginning to glaze. The corn stalks were in every case cut  
up from one and one-half to two inches in length  
before being fed.

The entire experiment extended over six successive  
months and was subdivided into nine distinct periods.  
Changes in daily diet were made gradually, as customary  
in conducted feeding experiments. The weekly weights  
of the animals on trial were taken on the same day, in the  
morning, before milking and feeding.

The adopted valuation of the different fodder articles is  
based on their local market price per ton of 2,000 pounds, at

: —

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Corn meal, per ton, . . . . .	\$19 00
Wheat bran, . . . . .	17 50
Old-process linseed meal, . . . . .	27 00
New-process linseed meal, . . . . .	26 00
Carrots, . . . . .	7 00
Sugar beets, . . . . .	5 00
Hay, . . . . .	15 00
Rowen, . . . . .	15 00
Fodder corn, . . . . .	5 00
Corn stover, . . . . .	5 00
Corn ensilage, . . . . .	2 75

A few subsequent pages contain an abstract of the results of the experiment, closing with a detailed feeding record for every cow on trial : —

## I. — *Statement of the Average of the Daily Fodder Combinations used during the Different Successive Feeding Periods.*

I.		II.	
Corn meal (pounds), . . . . .	3.25	Corn meal (pounds), . . . . .	3.25
Wheat bran, . . . . .	3.25	Wheat bran, . . . . .	3.25
Old-process linseed meal, . . . . .	3.25	Old-process linseed meal, . . . . .	3.25
Hay, . . . . .	18.50	Hay, . . . . .	18.50
Total cost (cents), . . . . .	24.18	Corn ensilage, . . . . .	4.37
Net cost, . . . . .	14.06	Total cost (cents), . . . . .	20.87
Manurial value obtainable, . . . . .	10.12	Net cost, . . . . .	10.50
Nutritive ratio, . . . . .	1 : 5.73	Manurial value obtainable, . . . . .	9.37
		Nutritive ratio, . . . . .	1 : 6.16

III.		IV.	
Wheat bran (pounds), . . . . .	3.25	Wheat bran (pounds), . . . . .	3.25
Old-process linseed meal, . . . . .	3.25	Old-process linseed meal, . . . . .	3.25
Carrots, . . . . .	20.00	Carrots, . . . . .	20.00
Fodder corn, . . . . .	13.75	Corn stover, . . . . .	10.00
Total cost (cents), . . . . .	17 65	Total cost (cents), . . . . .	16 50
Net cost, . . . . .	9.58	Net cost, . . . . .	9.50
Manurial value obtainable, . . . . .	8.07	Manurial value obtainable, . . . . .	8.87
Nutritive ratio, . . . . .	1 : 5.16	Nutritive ratio, . . . . .	1 : 5.16

I. — *Daily Fodder Combinations* — Concluded.

V.		VI.	
Corn (pounds), .	3.25	Corn meal (pounds), .	3.25
Process linseed meal, .	3.25	Wheat bran, .	3.25
Rowen, .	20.00	New-process linseed meal, .	3.25
Corn, .	16.25	Sugar beets, .	20.00
Cost (cents), .	18.06	Hay, .	16.00
Manurial value obtainable, .	8.91	Total cost (cents), .	27.16
Nutritive ratio, .	1:4.96	Net cost, .	16.38
		Manurial value obtainable, .	10.78
		Nutritive ratio, .	1:5.23

VII.		VIII.	
Corn meal (pounds), .	3.25	Corn meal (pounds), .	3.25
Wheat bran, .	3.25	Wheat bran, .	3.25
Process linseed meal, .	3.25	Old-process linseed meal, .	3.25
Rowen, .	20.00	Rowen, .	20.75
Corn, .	16.00	Total cost (cents), .	25.86
Cost (cents), .	27.30	Net cost, .	13.48
Manurial value obtainable, .	16.96	Manurial value obtainable, .	12.38
Nutritive ratio, .	1:5.63	Nutritive ratio, .	1:5.04

## IX.

Corn meal (pounds), .	3.25
Wheat bran, .	3.25
New-process linseed meal, .	3.25
Rowen, .	20.75
Total cost (cents), .	25.72
Net cost, .	13.05
Manurial value obtainable, .	12.67
Nutritive ratio, .	1:4.73

## Summary of the Cost of the Daily Fodder Rations (Cents).

	PERIODS.								
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Total cost, .	24.18	20.25	17.65	18.21	18.06	27.16	27.30	25.86	25.72
Net cost, .	14.06	10.79	9.58	9.20	9.12	16.38	16.96	13.48	13.05
Manurial value obtainable, .	10.12	9.46	8.07	9.01	8.94	10.78	10.34	12.38	12.67

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### II. — Daily Fodder Rations — Concluded.

#### *Valuation of Essential Fertilizing Constituents in the Various Fodder Articles used.*

Nitrogen, 17 cents per pound; phosphoric acid, 6 cents; potassium oxide, 4½ c

	Corn Meal.	Wheat Bran.	Old-process Oil Meal.	New-process Oil Meal.	Hay.	Corn Ensilage.	Fodder Corn.	Corn Stover.	Carrots.	Sugar Beets.
Moisture, . . .	11.67	9.27	9.88	5.06	9.72	72.95	20.42	22.50	90.47	90.02
Nitrogen, . . .	1.479	2.545	5.331	6.254	1.379	0.33	1.058	1.211	0.149	0.184
Phosphoric acid, .	0.713	2.900	1.646	1.420	0.359	0.138	0.510	0.303	0.100	0.086
Potassium oxide, .	0.430	1.637	1.162	1.160	1.572	0.301	0.760	1.320	0.540	0.462
Value per 2,000 lbs.,	\$6 27	\$13 60	\$21 15	\$24 00	\$6 53	\$1 56	\$4 89	\$5 67	\$1 12	\$1 14

### III. — Amount of Dry Vegetable Matter of the Feed required to produce One Quart of Milk during the Experiment.

NAME.	Average Yield of Milk per Day (Quarts).	Average Amount of Matter consumed to produce One Quart of Milk.
Juno, . . . . .	9.53	2.57
Flora, . . . . .	7.46	3.17
Jessie, . . . . .	7.40	3.09
Roxy, . . . . .	12.55	1.99
Pink, . . . . .	10.99	2.09

### IV. — Cost of Feed consumed for the Production of One Quart of Milk during the Different Feeding Periods (Cents).

FEEDING PERIODS, 1889-1890.		Juno.	Flora.	Jessie.	Roxy.
I.					
Dec. 11 to Dec. 31, . . .	{ Total cost, . . .	2.54	2.88	3.08	
	{ Net cost, . . .	1.48	1.68	1.79	
	{ Obtainable manure, . . .	1.06	1.20	1.29	
II.					
Jan. 6 to Feb. 16, . . .	{ Total cost, . . .	2.20	2.52	2.83	
	{ Net cost, . . .	1.17	1.34	1.51	
	{ Obtainable manure, . . .	1.03	1.18	1.32	

IV. — *Cost of Feed, etc.*—Concluded.

FEEDING PERIODS, 1889-1890.			Juno.	Flora.	Jessie.	Roxy.	Pink.
III.							
March 13,		{ Total cost, . . .	2 19	3.00	2.85	1.37	1.61
		{ Net cost, . . .	1.15	1 65	1.57	.72	.87
		{ Obtainable manure,	1.04	1.35	1.23	0.65	0.74
IV.							
April 5,		{ Total cost, . . .	2 24	2.81	2.72	1.63	1.76
		{ Net cost, . . .	1.13	1.43	1.39	.81	.87
		{ Obtainable manure,	1.11	1.38	1.33	0.82	0.89
V.							
April 18,		{ Total cost, . . .	2.19	2.47	2.37	1.60	1.68
		{ Net cost, . . .	1.11	1.25	1.21	.79	.85
		{ Obtainable manure,	1.08	1.22	1.16	0.81	0.83
VI.							
May 13,		{ Total cost, . . .	2.72	3.36	3.36	2.12	2.45
		{ Net cost, . . .	1.64	2.02	2.02	1.60	1.48
		{ Obtainable manure,	1.08	1.34	1.34	0.52	0.97
VII.							
May 27,		{ Total cost, . . .	2.71	3.48	3.45	2.24	2 46
		{ Net cost, . . .	1.69	2.16	2.14	1.39	1.53
		{ Obtainable manure,	1.02	1.32	1.31	0.85	0.93
VIII.							
June 19,		{ Total cost, . . .	2.38	3.19	3.10	2.10	2.17
		{ Net cost, . . .	1.25	1.67	1.62	1.11	1.10
		{ Obtainable manure,	1.13	1.52	1.48	0.99	1.07
IX.							
July 2,		{ Total cost, . . .	2.49	3.59	3.09	2.12	2.24
		{ Net cost, . . .	1.26	1 82	1.57	1.11	1.14
		{ Obtainable manure,	1.23	1.77	1.52	1.01	1.10

V. — *Average Quantity of Milk per Day (Quarts).*

FEEDING PERIODS, 1889-1890.								
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
9.67	9.40	8.47	8.18	8.30	10.04	10.06	11.05	10.61
8.64	8.41	5.73	6.45	7.26	7.86	7.64	7.89	7.29
7.87	7.16	6.05	6.57	7.44	7.75	7.48	8.19	8.09
		13.52	11.46	11.64	13.18	12.67	12.84	12.22
		10.09	10.59	10.65	11.30	11.05	12.06	11.19

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### V. — *Average Quantity of Milk, etc. — Concluded.*

I. — Variations in daily production of milk during the entire feeding experiment (quarts).

II. — Average quantity of milk per day for the entire feeding experiment (quarts).

	I.	II.
Juno, . . . . .	8.18 — 11.05	9.
Flora, . . . . .	5.73 — 8.64	7.
Jessie, . . . . .	6.05 — 8.19	7.
Roxy, . . . . .	11.46 — 13.52	12.
Pink, . . . . .	10.09 — 12.06	10.

### VI. — *Statement of the Average of Analyses of Milk made during the Different Feeding Periods.*

PERIODS.		Juno.	Flora.	Jessie.	Roxy.
I., . . . . .	{ Solids, per cent., Fat, per cent., .	12.84 3.89	13.47 3.72	14.72 5.21	
II., . . . . .	{ Solids, per cent., Fat, per cent., .	12.97 3.93	13.86 4.33	14.93 5.86	
III., . . . . .	{ Solids, per cent., Fat, per cent., .	13.68 4.33	15.44 6.00	15.61 6.45	13.27 4.21
IV., . . . . .	{ Solids, per cent., Fat, per cent., .	13.80 4.31	13.62 4.27	14.14 4.78	13.18 3.51
V., . . . . .	{ Solids, per cent., Fat, per cent., .	13.34 4.24	12.59 3.96	13.79 5.17	12.48 4.30
VI., . . . . .	{ Solids, per cent., Fat, per cent., .	14.37 4.76	13.30 3.71	14.93 5.57	13.21 3.91
VII., . . . . .	{ Solids, per cent., Fat, per cent., .	13.90 4.28	13.19 3.85	15.76 6.22	12.74 3.75
VIII., . . . . .	{ Solids, per cent., Fat, per cent., .	13.62 4.59	12.82 3.73	14.80 5.70	12.59 3.73
IX, . . . . .	{ Solids, per cent., Fat, per cent., .	13.85 4.45	12.93 3.52	14.43 5.13	12.81 3.68

## — Creamery Record for the Different Feeding Periods.

FEEDING PERIODS.	Quarts of Milk set for Cream.	Spaces of Cream produced.	Average Number of Spaces per Day.	Quarts of Milk produced One Space of Cream.
<b>1899-1890.</b>				
Dec. 11 to Dec. 31, .	933.50	657	31.29	1.42
Jan. 6 to Feb. 16, .	2,013.40	1,367	32.55	1.47
Feb. 23 to March 13,	913.74	602	31.68	1.52
March 18 to April 5,	1,002.75	627	33.00	1.60
April 9 to April 18, .	559.50	336	33.60	1.67
April 25 to May 13, .	1,159.50	665	35.00	1.74
May 18 to May 27, .	599.20	347	34.70	1.73
June 1 to June 19, .	1,201.50	676	35.58	1.76
June 23 to July 2, .	601.25	333	33.30	1.81

## — Live Weights of Animals during the Feeding Periods (Pounds).

NAME.	FEEDING PERIODS.									GAIN AT CLOSE.
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	
. . .	1,070	1,030	1,018	1,025	1,042	1,095	1,095	1,142	1,125	55
. . .	1,000	990	960	934	1,005	1,047	1,050	1,084	1,080	80
. . .	888	870	827	830	838	901	897	932	928	40
. . .			834	849	864	898	915	955	933	104
. . .			800	814	818	860	860	852	850	59

## IX. — Conclusion.

Examination of the previously recorded results of the feeding trials into the respective particular claims of both kinds of feed meal as food constituents for dairy purposes shows that, at stated market prices, under otherwise corresponding circumstances and when used in equal-weight parts, they may serve in place of each other without materially affecting the financial side of the operation one way or the



other. In case the new-process linseed meal is used, the cost of the milk is somewhat less, on account of the larger amount of fertilizing elements it contains, which increases somewhat the value of obtainable manure (see rations 6, 8 and 9). This advantage is, however, in the majority of instances, to some extent compensated for by a somewhat more liberal yield of milk, in case old-process linseed meal has been fed. As the old-process linseed meal has a well-established reputation as a suitable food constituent for dairy cows, the new-process linseed meal may claim a similar position in the front rank of concentrated feed stuffs for dairy purposes. A careful selection of suitable associated fodder constituents is, however, in both instances, necessary to show their real economical value. A comparison of the yield of milk obtained, in the majority of cases, during feeding periods III., IV., with those of periods VI., VII., VIII. and IX., cannot fail to render that point prominent.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.											Amount of Dry Vegetable Matter contained in the Daily Ration (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).	
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	New-process Linseed Meal.	Hay.	Corn Ensilage.	Fodder Corn.	Corn Stover.	Carrots.	Sugar Beets.	Howen.						
1899 - 1900.																	
Dec. 11 to Dec. 31,	3 25	3 25	3 25	-	18 95	-	-	-	-	-	-	25 34	9 67	2 67	1: 5.76	1 070	
Jan. 6 to Feb. 16,	3 25	3 25	3 25	-	5 00	47 81	-	-	-	-	-	26 17	9 40	2 78	1: 6.36	1 080	
Feb. 23 to March 13,	-	3 25	3 25	-	-	-	17 53	-	20 00	-	-	21 72	8 47	2 56	1: 5.51	1 018	
March 18 to April 5,	-	3 25	3 25	-	-	-	-	16 32	20 00	-	-	20 42	8 18	2 50	1: 5.17	1 025	
April 9 to April 18,	-	3 25	-	3 25	-	-	16 75	-	20 00	-	-	21 26	8 30	2 56	1: 5.01	1 042	
April 25 to May 13,	3 25	3 25	-	3 25	16 11	-	-	-	-	20 00	-	25 43	10 04	2 53	1: 5.24	1 095	
May 18 to May 27,	3 25	3 25	3 25	-	16 00	-	-	-	-	20 00	-	25 17	10 06	2 50	1: 5.63	1 095	
June 1 to June 19,	3 25	3 25	3 25	-	-	-	-	-	-	-	21 34	27 18	11 05	2 46	1: 5.08	1 142	
June 23 to July 2,	3 25	3 25	-	3 25	-	-	-	-	-	-	21 70	27 65	10 61	2 61	1: 4.77	1 125	
2. FLORA: Age, six years; grade, Durham; last calf, Dec. 22, 1888.																	
Dec. 11 to Dec. 31,	3 25	3 25	3 25	3 25	19 43	-	-	-	-	-	-	26 27	8 64	3 04	1: 5.79	1 000	
Jan. 6 to Feb. 16,	3 25	3 25	3 25	3 25	5 00	51 17	-	-	-	-	-	27 08	8 41	3 22	1: 6.44	990	
Feb. 23 to March 13,	-	3 25	3 25	3 25	-	-	11 95	-	20 00	-	-	17 28	5 73	3 02	1: 4.96	960	
March 18 to April 5,	-	3 25	3 25	3 25	-	-	-	15 74	20 00	-	-	19 97	6 45	3 09	1: 5.13	984	
April 9 to April 18,	-	3 25	-	3 25	-	-	15 70	-	20 00	-	-	20 42	7 26	2 81	1: 4.91	1 005	
April 25 to May 13,	3 25	3 25	-	3 25	15 00	-	-	-	-	20 00	-	24 43	7 86	3 11	1: 5.16	1 047	
May 18 to May 27,	3 25	3 25	3 25	3 25	15 00	-	-	-	-	20 00	-	24 27	7 64	3 18	1: 5.55	1 050	
June 1 to June 19,	3 25	3 25	3 25	3 25	-	-	-	-	-	-	19 79	25 34	7 89	3 28	1: 5.01	1 084	
June 23 to July 2,	3 25	3 25	-	3 25	-	-	-	-	-	-	21 40	27 39	7 29	3 76	1: 4.75	1 080	

## FEEDING RECORD — Continued.

## 3. JESSIE: Age, six years; grade, Jersey; last calf, Jan. 12, 1889.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.										Amount of Dry Vegetable Matter contained in the Daily Ration (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	New-process Linseed Meal.	Hay.	Corn Ensilage.	Fodder Corn.	Corn Stover.	Carrots.	Sugar Beets.	Rowen.				
1889-1890.															
Dec. 11 to Dec. 31,	3.25	3.25	3.25	-	18.43	-	-	-	-	-	-	7.87	3.22	1:5.72	888
Jan. 6 to Feb. 16,	3.25	3.25	3.25	-	5.00	45.02	-	-	-	-	-	7.16	3.55	1:6.27	870
Feb. 23 to March 13,	-	3.25	3.25	-	-	-	12.21	-	20.00	-	-	6.05	2.89	1:5.00	827
March 18 to April 5,	-	3.25	3.25	-	-	-	-	14.47	20.00	-	-	6.57	2.89	1:5.02	830
April 9 to April 18,	-	3.25	-	3.25	-	-	14.30	-	20.00	-	-	7.44	2.60	1:4.78	838
April 25 to May 13,	3.25	3.25	-	3.25	14.53	-	-	-	-	20.00	-	7.75	3.10	1:5.12	901
May 18 to May 27,	3.25	3.25	3.25	-	14.00	-	-	-	-	20.00	-	7.48	3.12	1:5.47	897
June 1 to June 19,	3.25	3.25	3.25	-	-	-	-	-	-	-	20.16	8.19	3.19	1:5.02	992
June 23 to July 2,	3.25	3.25	3.25	3.25	-	-	-	-	-	-	19.90	8.09	3.22	1:4.69	928

## 4. ROXY: Age, seven years; grade, Ayrshire; last calf, Feb. 5, 1890.

FEEDING PERIODS.	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	New-process Linseed Meal.	Hay.	Corn Ensilage.	Fodder Corn.	Corn Stover.	Carrots.	Sugar Beets.	Rowen.	Amount of Dry Vegetable Matter contained in the Daily Ration (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
Feb. 23 to March 13,	-	3.25	3.25	-	-	-	17.21	-	20.00	-	-	21.47	13.52	1.59	1:5.48	884
March 18 to April 5,	-	3.25	3.25	-	-	-	-	18.11	20.00	-	-	21.81	11.46	1.90	1:5.30	849
April 9 to April 18,	-	3.25	-	3.25	-	-	18.30	-	20.00	-	-	22.49	11.64	1.93	1:5.15	864
April 25 to May 13,	3.25	3.25	-	3.25	17.05	-	-	-	-	20.00	-	26.28	13.18	1.99	1:5.31	898
May 18 to May 27,	3.25	3.25	3.25	-	17.40	-	-	-	-	20.00	-	26.44	12.67	2.09	1:5.73	915
June 1 to June 19,	3.25	3.25	3.25	3.25	-	-	-	-	-	-	22.16	27.89	12.84	2.17	1:5.11	955

## 5. PINK : Age, six years ; native ; last calf, Jan. 23, 1890.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.										Amount of Dry Veg- etable Matter con- tained in the Daily Fodder consumed (Pounds).	Quarts of Milk pro- duced per Day.	Pounds of Dry Mat- ter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	New-process Linseed Meal.	Hay.	Corn Chaffage.	Fodder Corn.	Corn Stover.	Carrots.	Sugar Beets.	Rowen.				
1890.															
Feb. 23 to March 13,	-	3.25	3.25	-	-	-	11.05	-	17.90	-	-	10.09	1.62	1:4.87	800
March 18 to April 5,	-	3.25	3.25	-	-	-	-	17.74	20.00	-	-	10.59	2.03	1:5.27	814
April 9 to April 18,	-	3.25	-	3.25	-	-	15.60	-	20.00	-	-	10.65	1.91	1:4.90	818
April 25 to May 13,	3.25	3.25	-	3.25	16.79	-	-	-	-	20.00	-	11.80	2.31	1:5.29	860
May 18 to May 27,	3.25	3.25	-	-	15.80	-	-	-	-	20.00	-	11.05	2.26	1:5.61	860
June 1 to June 19,	3.25	3.25	3.25	-	-	-	-	-	-	-	20.37	12.06	2.18	1:5.02	852
June 23 to July 2,	3.25	3.25	-	3.25	-	-	-	-	-	-	20.00	11.19	2.34	1:4.69	859

## 6. NANCY : Age, seven years ; native ; last calf, March 16, 1890.

March 25 to April 5,	-	3.25	3.25	-	-	-	-	13.50	20.00	-	-	18.28	1.44	1:4.94	860
May 18 to May 27,	3.25	3.25	3.25	-	15.80	-	-	-	-	20.00	-	13.02	1.92	1:5.61	875
June 1 to June 19,	3.25	3.25	3.25	-	-	-	-	-	-	-	19.76	13.21	1.95	1:5.01	900
June 23 to July 2,	3.25	3.25	-	3.25	-	-	-	-	-	-	19.70	12.74	2.04	1:4.67	889

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## TOTAL COST OF FEED PER QUART OF MILK.

I. *June.*

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of New-process Linseed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Corn Ration consumed (Pounds).	Total Amount of Red-top consumed (Pounds).	Total Amount of Corn Stover consumed (Pounds).	Total Amount of Carrots consumed (Pounds).	Total Amount of Sugar Beets consumed (Pounds).	Total Amount of Howeren consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
<b>1899-1900.</b>															
Dec. 11 to Dec. 31,	203.02	9.67	68.25	68.25	68.25	-	398.00	-	-	-	-	-	-	\$5 16	2.54
Jan. 6 to Feb. 16,	394.88	9.40	136.50	136.50	136.50	-	210.00	2,008.00	333.00	-	380.00	-	-	8 68	2.20
Feb. 23 to March 13,	160.93	8.47	-	61.75	61.75	-	-	-	-	-	-	-	-	8 53	2.19
March 18 to April 5,	155.35	8.18	-	61.75	61.75	-	-	-	-	-	-	-	-	8 48	2.24
April 9 to April 18,	83.02	8.30	-	32.50	-	32.50	-	-	167.50	310.00	200.00	-	-	1 82	2.19
April 25 to May 13,	190.70	10.04	61.75	61.75	-	61.75	906.00	-	-	-	-	380.00	-	5 18	2.72
May 18 to May 27,	100.58	10.06	32.50	32.50	-	61.75	160.00	-	-	-	-	200.00	-	2 73	2.71
June 1 to June 19,	209.88	11.05	61.75	61.75	61.75	-	-	-	-	-	-	-	405.50	5 00	2.98
June 23 to July 2,	106.05	10.61	32.50	32.50	-	32.50	-	-	-	-	-	-	217.00	2 64	2.49

## TOTAL COST OF FEED PER QUART OF MILK — Continued.

2. *Flora.*

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of New-process Linseed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Corn Huslage consumed (Pounds).	Total Amount of Fedder Corn consumed (Pounds).	Total Amount of Corn Rower consumed (Pounds).	Total Amount of Carrots consumed (Pounds).	Total Amount of Sugar Beets consumed (Pounds).	Total Amount of Kowen consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1899-1900.															
Dec. 11 to Dec. 31,	181.50	8.64	68.25	68.25	68.25	-	408.00	-	-	-	-	-	-	\$5.23	2.88
Jan. 6 to Feb. 16,	353.02	8.41	136.50	136.50	136.50	-	210.00	2,149.00	227.00	-	-	-	-	8.88	2.52
Feb. 23 to March 13,	108.84	5.73	-	61.75	61.75	-	-	-	-	-	380.00	-	-	8.27	3.00
March 18 to April 5,	122.56	6.45	-	61.75	61.75	-	-	-	-	299.00	380.00	-	-	3.45	2.81
April 9 to April 18,	72.56	7.26	-	32.50	32.50	32.50	-	-	157.00	-	200.00	-	-	1.79	2.47
April 25 to May 13,	149.32	7.86	61.75	61.75	-	61.75	285.00	-	-	-	-	380.00	-	5.02	3.36
May 18 to May 27,	76.40	7.64	32.50	32.50	32.50	-	150.00	-	-	-	-	200.00	-	2.66	3.48
June 1 to June 19,	150.00	7.89	61.75	61.75	61.75	-	-	-	-	-	-	-	376.00	4.78	3.19
June 23 to July 2,	72.91	7.29	32.50	32.50	-	32.50	-	-	-	-	-	-	214.00	2.62	3.59

## TOTAL COST OF FEED PER QUART OF MILK — Continued.

## 3. Jesse.

FEEDING PERIODS.	Total Quantity of Milk Produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Old process Linseed Meal consumed (Pounds).	Total Amount of New process Linseed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Corn Rations consumed (Pounds).	Total Amount of Clover consumed (Pounds).	Total Amount of Sugar Beets consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1898-1899.													
Dec. 11 to Dec. 31,	165.25	7.87	68.25	68.25	68.25	-	387.00	-	-	-	-	\$5.07	3.08
Jan. 6 to Feb. 16,	300.70	7.16	136.50	136.50	136.50	-	210.00	-	-	-	-	8.52	2.83
Feb. 23 to March 13,	115.00	6.05	-	61.75	61.75	-	-	232.00	-	-	-	3.28	2.85
March 18 to April 5,	124.75	6.57	-	61.75	61.75	-	-	-	-	-	-	3.39	2.72
April 9 to April 18,	74.40	7.44	-	32.50	-	32.50	-	-	-	-	-	1.76	2.97
April 23 to May 13,	147.25	7.75	61.75	61.75	-	61.75	276.00	-	-	380.00	-	4.95	3.36
May 18 to May 27,	74.77	7.48	32.50	32.50	32.50	-	140.00	-	-	200.00	-	2.58	3.45
June 1 to June 19,	155.70	8.19	61.75	61.75	61.75	-	-	-	-	-	383.00	4.83	3.10
June 23 to July 2,	80.93	8.09	32.50	32.50	-	32.50	-	-	-	-	199.00	2.50	3.09

## 4. Rozzy.

FEEDING PERIODS.	Total Quantity of Milk Produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Old process Linseed Meal consumed (Pounds).	Total Amount of New process Linseed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Corn Rations consumed (Pounds).	Total Amount of Clover consumed (Pounds).	Total Amount of Sugar Beets consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
Feb. 23 to March 13,	256.86	13.52	-	61.75	61.75	-	-	-	-	-	-	\$3.52	1.97
March 18 to April 5,	217.75	11.46	-	61.75	61.75	-	-	-	-	-	-	3.56	1.63
April 9 to April 18,	116.40	11.64	-	32.50	-	32.50	-	-	-	-	-	1.86	1.60
April 25 to May 13,	250.35	13.18	61.75	61.75	-	61.75	324.00	-	-	380.00	-	5.31	2.12
May 18 to May 27,	126.74	12.67	32.50	32.50	32.50	-	174.00	-	-	200.00	-	2.84	2.24
June 1 to June 19,	243.95	12.84	61.75	61.75	61.75	-	-	-	-	-	421.00	5.12	2.10
June 23 to July 2,	199.91	19.92	32.50	32.50	32.50	32.50	-	-	-	-	219.00	9.65	3.17

Cost of Feed per  
5. *1911.*

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of New-process Linseed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Corn Rensilage consumed (Pounds).	Total Amount of Redder Corn consumed (Pounds).	Total Amount of Corn Stover consumed (Pounds).	Total Amount of Carrots consumed (Pounds).	Total Amount of Sugar Beets consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
<b>1890.</b>															
Feb. 28 to March 13,	191.74	10.09	—	61.75	61.75	—	—	—	210.00	—	840.00	—	—	\$3.09	1.61
March 18 to April 5,	201.16	10.59	—	61.75	61.75	—	—	—	—	387.00	380.00	—	—	3.54	1.76
April 9 to April 18,	106.51	10.65	—	32.50	—	32.50	—	—	156.00	—	200.00	—	—	1.79	1.68
April 25 to May 13,	214.75	11.30	61.75	61.75	—	61.75	319.00	—	—	—	—	380.00	—	5.27	2.45
May 18 to May 27,	110.47	11.05	32.50	32.50	32.50	—	158.00	—	—	—	—	200.00	—	2.72	2.46
June 1 to June 19,	229.07	12.06	61.75	61.75	61.75	—	—	—	—	—	—	—	387.00	4.86	2.12
June 23 to July 2,	111.86	11.19	32.50	32.50	—	32.50	—	—	—	—	—	—	200.00	2.51	2.24

6. *Nancy.*

March 25 to April 5,	152.44	12.70	—	39.00	39.00	—	—	—	—	162.00	240.00	—	—	\$2.12	1.39
May 18 to May 27,	130.23	13.02	32.50	32.50	32.50	—	158.00	—	—	—	—	200.00	—	2.72	2.09
June 1 to June 19,	250.93	13.21	61.75	61.75	61.75	—	—	—	—	—	—	—	875.50	4.78	1.90
June 23 to July 2,	127.35	12.74	32.50	32.50	—	32.50	—	—	—	—	—	—	197.00	2.49	1.96



# 32 AGRICULTURAL EXPERIMENT STATION. [

## NET COST OF MILK AND MANURIAL VALUE OF FEED.

### 1. Juno.

FEEDING PERIODS.	Total Cost of Feed consumed during Period.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting the Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.
<b>1899 - 1900.</b>					Cents.
Dec. 11 to Dec. 31, .	\$5 16	\$2 69	\$2 15	\$3 01	1.48
Jan. 6 to Feb. 16, .	8 68	5 06	4 05	4 63	1.17
Feb. 23 to Mar. 13, .	3 53	2 40	1 68	1 85	1.15
Mar. 18 to Apr. 5, .	3 48	2 16	1 73	1 75	1.13
Apr. 9 to Apr. 18, .	1 82	1 13	90	92	1.11
Apr. 25 to May 13, .	5 18	2 57	2 06	3 12	1.64
May 18 to May 27, .	2 73	1 29	1 03	1 70	1.69
June 1 to June 19, .	5 00	2 97	2 38	2 62	1.25
June 23 to July 2, .	2 64	1 62	1 30	1 34	1.26
<b>Total, . .</b>	<b>\$38 22</b>	<b>\$21 59</b>	<b>\$17 28</b>	<b>\$20 94</b>	<b>-</b>

### 2. Flora.

Dec. 11 to Dec. 31, .	\$5 23	\$2 72	\$2 18	\$3 05	1.68
Jan. 6 to Feb. 16, .	8 88	5 17	4 14	4 74	1.34
Feb. 23 to Mar. 13, .	3 27	1 84	1 47	1 80	1.65
Mar. 18 to Apr. 5, .	3 45	2 13	1 70	1 75	1.43
Apr. 9 to Apr. 18, .	1 79	1 10	88	91	1.25
Apr. 25 to May 13, .	5 02	2 50	2 00	3 02	2.02
May 18 to May 27, .	2 66	1 26	1 01	1 65	2.16
June 1 to June 19, .	4 78	2 84	2 27	2 51	1.67
June 23 to July 2, .	2 62	1 61	1 29	1 33	1.82
<b>Total, . .</b>	<b>\$37 70</b>	<b>\$21 17</b>	<b>\$16 94</b>	<b>\$20 76</b>	<b>-</b>

### 3. Jessie.

Dec. 11 to Dec. 31, .	\$5 07	\$2 65	\$2 12	\$2 95	1.79
Jan. 6 to Feb. 16, .	8 52	4 96	3 97	4 55	1.51
Feb. 23 to Mar. 13, .	3 28	1 85	1 48	1 80	1.57
Mar. 18 to Apr. 5, .	3 39	2 06	1 65	1 74	1.39
Apr. 9 to Apr. 18, .	1 76	1 07	86	90	1.21
Apr. 25 to May 13, .	4 95	2 47	1 98	2 97	2.02
May 18 to May 27, .	2 58	1 23	98	1 60	2.14
June 1 to June 19, .	4 83	2 87	2 30	2 53	1.62
June 23 to July 2, .	2 50	1 54	1 23	1 27	1.57
<b>Total, . .</b>	<b>\$36 88</b>	<b>\$20 70</b>	<b>\$16 57</b>	<b>\$20 31</b>	<b>-</b>

COST OF MILK AND MANURIAL VALUE OF FEED—*Concluded.*4. *Rozy.*

FEEDING PERIODS.	Total Cost of Feed consumed during Period.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting the Twenty Per Cent taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
<b>1890.</b>					Centa.	Pounds.
23 to Mar. 13, .	\$3 52	\$2 08	\$1 66	\$1 86	.72	840
18 to Apr. 5, .	3 56	2 25	1 80	1 76	.81	853
9 to Apr. 18, .	1 86	1 17	94	92	.79	875
25 to May 13, .	5 31	1 63	1 30	4 01	1.60	906
18 to May 27, .	2 84	1 34	1 07	1 77	1.39	925
1 to June 19, .	5 12	3 03	2 42	2 70	1.11	958
23 to July 2, .	2 65	1 63	1 30	1 35	1.10	940
Total, . . .	\$24 86	\$13 13	\$10 49	\$14 37	—	—

5. *Pink.*

FEEDING PERIODS.	Total Cost of Feed consumed during Period.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting the Twenty Per Cent taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
<b>1890.</b>					Centa.	Pounds.
23 to Mar. 13, .	\$3 09	\$1 77	\$1 42	\$1 67	0.87	773
18 to Apr. 5, .	3 54	2 23	1 78	1 76	0.87	820
9 to Apr. 18, .	1 79	1 10	88	91	0.85	825
25 to May 13, .	5 27	2 61	2 09	3 18	1.48	878
18 to May 27, .	2 72	1 29	1 03	1 69	1.53	862
1 to June 19, .	4 86	2 89	2 31	2 55	1.11	855
23 to July 2, .	2 51	1 55	1 24	1 27	1.14	859
Total, . . .	\$23 78	\$13 44	\$10 75	\$13 03	—	—

6. *Nancy.*

FEEDING PERIODS.	Total Cost of Feed consumed during Period.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting the Twenty Per Cent taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
<b>1890.</b>					Centa.	Pounds.
25 to Apr. 5, .	\$2 12	\$1 27	\$1 02	\$1 10	0.72	840
18 to May 27, .	2 72	1 29	1 03	1 69	1.30	882
1 to June 19, .	4 78	2 84	2 27	2 51	1.00	898
23 to July 2, .	2 49	1 54	1 23	1 26	0.99	889
Total, . . .	\$12 11	\$6 93	\$5 55	\$6 56	—	—

# 34 AGRICULTURAL EXPERIMENT STATION.

## *Composition of Fodder Articles fed during the Previous Described Feeding Experiments.*

### *Corn Meal (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.
Moisture at 100° C., . . . .	11.67	233.40	-	-
Dry matter, . . . . .	88.33	1,766.60	-	-
	100.00	2,000.00	-	-
<i>Analysis of Dry Matter.</i>				
Crude ash, . . . . .				
“ cellulose, . . . . .	1.89	37.80	-	-
“ fat, . . . . .	1.44	28.80	9.79	34
“ protein (nitrogenous matter), . . . . .	4.44	88.80	67.49	76
	10.46	209.20	177.82	85
Non-nitrogenous extract matter, . . . . .	81.77	1,635.40	1,537.28	94
	100.00	2,000.00	1,792.88	-

### *Wheat Bran (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.
Moisture at 100° C., . . . .	9.27	185.40	-	-
Dry matter, . . . . .	90.73	1,814.60	-	-
	100.00	2,000.00	-	-
<i>Analysis of Dry Matter.</i>				
Crude ash, . . . . .	7.47	149.40	-	-
“ cellulose, . . . . .	9.75	195.00	39.00	20
“ fat, . . . . .	5.48	109.60	87.68	80
“ protein (nitrogenous matter), . . . . .	17.53	350.60	308.53	88
Non-nitrogenous extract matter, . . . . .	59.77	1,195.40	956.32	80
	100.00	2,000.00	1,391.53	-

*Composition of Fodder Articles, etc.—Continued.*

*Old-process Linseed Meal (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
ure at 100° C., . . .	9.88	197.60	—	—	1:1.70
matter,. . . . .	90.12	1,802.40	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
ash, . . . . .	7.39	147.80	—	—	
cellulose, . . . .	8.74	174.80	45.45	26	
fat, . . . . .	7.24	144.80	131.77	91	
protein (nitrogenous matter), . . . .	36.97	739.40	643.28	87	
nitrogenous extract matter, . . . . .	39.66	793.20	721.81	91	
	100.00	2,000.00	1,542.31	—	

*New-process Linseed Meal (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
ure at 100° C., . . .	5.06	101.20	—	—	1:1.26
matter,. . . . .	94.94	1,898.80	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
ash, . . . . .	6.34	126.80	—	—	
cellulose, . . . .	8.93	178.60	46.44	26	
fat, . . . . .	2.17	43.40	39.49	91	
protein (nitrogenous matter), . . . .	41.02	820.40	713.75	87	
nitrogenous extract matter, . . . . .	41.54	830.80	756.03	91	
	100.00	2,000.00	1,555.71	—	

## 36 AGRICULTURAL EXPERIMENT STATION.

*Composition of Fodder Articles, etc. — Continued.**Hay (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.
Moisture at 100° C., . . .	9.72	194.40	—	—
Dry matter, . . . . .	90.28	1,805.60	—	—
	100.00	2,000.00	—	—
<i>Analysis of Dry Matter.</i>				
Crude ash, . . . . .	6.43	128.60	—	—
“ cellulose, . . . . .	32.28	645.60	374.45	58
“ fat, . . . . .	2.49	49.80	22.91	46
“ protein (nitrogenous matter), . . . . .	9.54	190.80	108.76	57
Non-nitrogenous extract matter, . . . . .	49.26	985.20	620.68	63
	100.00	2,000.00	1,126.80	—

*Rowen \* (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.
Moisture at 100° C., . . .	13.53	270.60	—	—
Dry matter, . . . . .	86.47	1,729.40	—	—
	100.00	2,000.00	—	—
<i>Analysis of Dry Matter.</i>				
Crude ash, . . . . .	6.81	136.20	—	—
“ cellulose, . . . . .	28.31	566.20	328.40	58
“ fat, . . . . .	3.81	76.20	35.05	46
“ protein (nitrogenous matter), . . . . .	12.94	258.80	147.52	57
Non-nitrogenous extract matter), . . . . .	48.13	962.60	606.44	63
	100.00	2,000.00	1,117.41	—

\* Dried second cut of meadow growth.

*Composition of Fodder Articles, etc.—Continued.**Corn Ensilage (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.	
Moisture at 100° C., . . .	72.95	1,459.00	-	-	1:11.67	
Organic matter,. . . . .	27.05	541.00	-	-		
	100.00	2,000.00	-	-		
<i>Analysis of Dry Matter.</i>						
Moisture, . . . . .	6.48	129.60	-	-		
Cellulose,. . . . .	26.33	526.60	379.15	72		
Fat, . . . . .	5.17	103.40	77.55	75		
Protein (nitrogenous matter), . . . . .	7.64	152.80	111.54	73		
Non-nitrogenous extract matter, . . . . .	54.38	1,087.60	728.69	67		
	100.00	2,000.00	1,296.93	-		

*Fodder Corn.*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.	
Moisture at 100° C., . . .	20.42	408.40	—	—	} 1 : 9.80	
Organic matter,. . . . .	79.58	1,591.60	—	—		
	100.00	2,000.00	—	—		
<i>Analysis of Dry Matter.</i>						
Moisture, . . . . .	7.40	148.00	—	—		
Cellulose,. . . . .	20.11	402.20	289.58	72		
Fat, . . . . .	1.65	33.00	24.75	75		
Protein (nitrogenous matter), . . . . .	8.31	166.20	121.33	73		
Non-nitrogenous extract matter, . . . . .	62.53	1,250.60	837.90	67		
	100.00	2,000.00	1,273.56	—		

*Composition of Fodder Articles, etc. — Continued.**Corn Stover.*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.
Moisture at 100° C., . . .	22.50	450.00	—	—
Dry matter, . . . . .	77.50	1,550.00	—	—
	100.00	2,000.00	—	—
<i>Analysis of Dry Matter.</i>				
Crude ash, . . . . .	3.97	79.40	—	—
“ cellulose, . . . . .	34.96	699.20	503.42	72
“ fat, . . . . .	1.54	30.80	23.10	75
“ protein (nitrogenous matter), . . . . .	9.76	195.20	142.50	73
Non-nitrogenous extract matter, . . . . .	49.77	995.40	666.92	67
	100.00	2,000.00	1,335.94	—

*Carrots.*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.
Moisture at 100° C., . . .	90.47	1,809.40	—	—
Dry matter, . . . . .	9.53	190.60	—	—
	100.00	2,000.00	—	—
<i>Analysis of Dry Matter.</i>				
Crude ash, . . . . .	8.67	173.40	—	—
“ cellulose, . . . . .	8.16	163.20	163.20	100
“ fat, . . . . .	1.86	37.20	37.20	100
“ protein (nitrogenous matter), . . . . .	9.18	183.60	183.60	100
Non-nitrogenous extract matter, . . . . .	72.13	1,442.60	1,442.60	100
	100.00	2,000.00	1,826.60	—

*Composition of Fodder Articles, etc. — Concluded.**Sugar Beets.*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
ture at 100° C., . . .	90.02	1,800.40	-	-	} 1:6.74
matter, . . . . .	9.98	199.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
ash, . . . . .	11.84	236.80	-	-	
cellulose, . . . . .	8.20	164.00	164.00	100	
fat, . . . . .	.71	14.20	14.20	100	
protein (nitrogenous matter), . . . . .	11.53	230.60	230.60	100	
nitrogenous extract matter, . . . . .	67.72	1,354.40	1,354.40	100	
	100.00	2,000.00	1,763.20	-	

3. *Summer Feeding Experiments with Milch Cows.*  
*July 12 to Sept. 30, 1890.*

Green Crops vs. English Hay, first and second cut.

Green feed: vetch and oats, soja beans.

Straw feed: corn meal, wheat bran, new-process linseed meal.

A series of feeding experiments with milch cows have been carried on at the station, since 1887, for the purpose of ascertaining the feeding value of several reputed fodder crops new to our section of the country. The new fodder crops were fed in their green state, and their nutritive value, as well as their general economical merits, compared with those of a good average English hay, first and second cut (English). The cutting of the new fodder crops for fodder was commenced at the beginning of their blooming, and continued until their maturing. Most of them had at that time that some of their seeds matured, yet their stems were still succulent.



The results obtained in this connection in previous years have already been published in our previous annual reports five, six and seven; they were considered on the whole of a sufficient degree encouraging to advise a continuation of investigations in that direction. For details regarding the merits of Southern cow-pea, serradella, vetch, vetch and oats and vetch and barley, as substitutes in part or in whole of an average English hay and rowen, as coarse fodder ingredients of the daily diet in case of the same kind and the same quantities of grain feed, I have to refer to some of our previous annual reports.

1890. — During our late experiments, July 12 to September 30, we used the following fodder articles in the composition of the daily diet: a mixed crop of green vetch and oats, or green soja beans, with first and second cut dried upland meadow growth, English hay and rowen, furnished the coarse feed, while corn meal, wheat bran and new-process linseed meal (Cleveland) served as fine or grain feed. The kind and the quantity of the daily grain feed remained the same during the entire experiment, *i.e.*, corn meal, wheat bran and new-process linseed meal, each three and one-quarter pounds daily per head of cows; five pounds of hay, with all the green crop the cows would consume, finished the daily diet. The green crops were cut in pieces from six to eight inches long before being fed. One-half of the daily ration of grain feed and of green fodder was fed during milking in the morning, and the other half during milking in the evening; the hay was fed between the meals. The daily quantities of grain and of hay remained the same, both being entirely consumed. The daily consumption of the green feed, however, was decided by the appetite of the different cows; vetch and oats varied from fifty to sixty pounds, and soja beans from forty to sixty pounds. The quantity consumed per day decreased in all cases toward the maturing of the crop, on account of the gradual increase of solid matter in the crop. The following statement contains the average daily fodder rations per head; they succeeded each other in the order in which they are reported: —

*Daily Fodder Rations used.*

## I.

meal, . . . . .	3.25 lbs.
eat bran, . . . . .	3.25 "
-process linseed meal, . . . . .	3.25 "
. . . . .	5.00 "
h and oats, . . . . .	54.00 "
l cost, . . . . .	22.64 cts.
cost, . . . . .	12.22 "
urial value obtainable, . . . . .	10.42 "
ritive ratio, . . . . .	1:5.97

## II.

meal, . . . . .	3.25 lbs.
eat bran, . . . . .	3.25 "
-process linseed meal, . . . . .	3.25 "
. . . . .	5.00 "
bean, . . . . .	55.00 "
l cost, . . . . .	27.31 cts.
cost, . . . . .	15.02 "
urial value obtainable, . . . . .	12.29 "
ritive ratio, . . . . .	1:4.69

## III.

meal, . . . . .	3.25 lbs.
eat bran, . . . . .	3.25 "
-process linseed meal, . . . . .	3.25 "
en, . . . . .	20.00 "
l cost, . . . . .	26.46 cts.
cost, . . . . .	14.28 "
urial value obtainable, . . . . .	12.18 "
ritive ratio, . . . . .	1:4.92

*Price per Ton of the Fodder Articles used in our Valuations.*

meal, . . . . .	\$24 00
eat bran, . . . . .	20 00
-process linseed meal, . . . . .	26 50
. . . . .	15 00
h and oats (green), . . . . .	2 75
bean (green), . . . . .	4 40
en (dry second cut of grass), . . . . .	15 00

The valuation of green vetch and oats and of green soja  
 ns is based on the value adopted for English hay, allow-  
 two tons of English hay or six tons of green grass as  
 average produce per year for an acre of a good meadow.

The remaining fodder articles were sold at the stated price per ton in our local market of feed stuffs. Some information regarding the raising of vetch and oats and of soy beans will be found farther on in the description of our field experiments.

*Valuation of Essential Fertilizing Constituents contained in the Various Fodder Articles used.*

Nitrogen, 17 cents per pound; phosphoric acid, 6 cents; potassium oxide, 4½ cents.

	Corn Meal.	Wheat Bran.	New-process Linseed Meal.	Hay.	Vetch and Oats.	Soja Beans.	Rowen.
Moisture at 100° C.,	12.39	11.52	10.06	9.72	76.21	72.95	13.50
Nitrogen, . . .	1.466	2.600	5.392	1.379	0.293	0.590	1.100
Phosphoric acid, .	0.707	2.870	1.800	0.352	0.159	0.193	0.100
Potassium oxide, .	0.435	1.620	1.570	1.541	0.566	0.311	1.100
Valuation per 2,000 pounds, . . .	\$6 22	\$13 74	\$21 90	\$6 50	\$1 70	\$2 52	\$8 00

Six cows, grades, from five to six years old, and in different stages of their milking period, were selected for experiment. They had been fed, previous to the observation, on a daily ration of corn meal, wheat bran and new-process linseed meal, each 3¼ pounds, with all the rowen called for, — from 20 to 22 pounds per head. Their average daily milk record at that time was as follows: —

1. Jessie, . . . . . from 7.5 to 8 quarts.
2. Roxy, . . . . . from 10 to 11 quarts.
3. Pink, . . . . . from 11 to 12 quarts.
4. Nancy, . . . . . from 11 to 12 quarts.
5. Juno, . . . . . from 9 to 10 quarts.
6. Pearl, . . . . . from 13 to 14 quarts.

The time of observation was subdivided into three periods which were characterized by the change from vetch and oats to soja beans, and terminating with rowen, as the sole article of coarse food constituents. The grain feed remained the same during the three different feeding periods.

the results of the last experiment lead to similar conclusions as our preceding experiments in 1887, 1888 and 1889, with green vetch, green Southern cow-pea, green adrella and mixed green crops of vetch and oats and vetch barley. (See Report seven, page 50.)

*Conclusions of 1890.*

The amount of dry matter in the feed consumed during different feeding periods for the production of one quart of milk obtained, varied from 3.32 to 3.55 pounds in case of daily milk production of from 7 to 8 quarts (Jessie); it varied from 2.62 to 2.99 pounds (Pink), when from 9 to 10 quarts was the daily production of milk; and it was from 1.75 to 1.75 pounds per quart of milk produced when the yield rose to from 13 to 14 quarts (Pearl). The variations in the numerical relation of the amount of dry matter of the feed consumed for the production of one quart of milk, in the case of the same animal and the same kind of feed, are essentially due to a more or less advanced stage of the milk-producing period of the animal on trial; yet they rarely correspond in the case of different animals. Constitutional differences quite frequently modify the results under otherwise corresponding conditions.

The total cost of the feed consumed in connection with the production of one quart of milk differed during the different feeding period, in case of different animals, from 1.69 cents to 3.43 cents; 1.69 cents in case of Pearl and 3.43 cents in case of Jessie, second feeding period, — soja beans. This difference is mainly due to the rate of the daily yield of milk; yet constitutional peculiarities sometimes affect essentially the final results.

The net cost of the feed consumed for the production of one quart of milk varied in case of different cows from 0.33 cents to 1.88 cents; Pearl 0.93 cents and Jessie 1.88 cents, second period, — soja bean ration.

The market value of the obtainable manurial refuse amounts per quart of milk produced on an average to more than three-sevenths part of the entire cost of the daily ration. Net cost of feed represents the money value of the feed after 80 per cent. of the manurial value of the

phosphoric acid, potassium oxide and nitrogen it contains has been deducted.

5. The soja bean exceeds in our case in five out of six cases the vetch and oats in feeding effect. Vetch and oats compare well with a good rowen. The latter leads the English hay thus far in all our observations with milk production.

6. Judging from our own experience, we can only recommend very highly the practice of raising any of the state new fodder crops, after due consideration of local circumstances, either alone or as mixed crops, for the purpose of increasing the fodder resources of the farm during summer and autumn. They may serve as green fodder as well as hay; most of them have a higher nutritive ratio than either English hay, corn fodder or corn stover: they tend to improve the soil chemically and physically; they yield liberal returns, and are, as a rule, highly relished by cattle.

## FEEDING RECORD.

JESSIE: Age, six years; grade, Jersey; last calf, Jan. 12, 1889.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.							Amount of Dry Vegetable Matter contained in the Daily Ration consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	New-process Linseed Meal.	Hay.	Vetch and Oats.	Soja Bean.	Rowen.					
1890.												
July 12 to Aug. 1, . . . . .	3.25	3.25	3.25	4.38	50.10	—	—	24.52	7.23	3.39	1: 5.82	901
Aug. 12 to Sept. 1, . . . . .	3.25	3.25	3.25	5.00	—	57.67	—	28.76	8.11	3.55	1: 4.70	908
Sept. 10 to Sept. 30, . . . . .	3.25	3.25	3.25	—	—	—	19.24	25.29	7.60	3.33	1: 4.89	924

ROXY: Age, seven years; grade, Ayrshire; last calf, Feb. 5, 1890.

July 12 to Aug. 1, . . . . .	3.25	3.25	3.25	5.00	59.14	—	—	10.13	2.69	1: 6.10	950
Aug. 12 to Sept. 1, . . . . .	3.25	3.25	3.25	5.00	—	60.29	—	9.97	2.96	1: 4.72	954
Sept. 10 to Sept. 30, . . . . .	3.25	3.25	3.25	—	—	—	20.95	8.03	3.33	1: 4.96	1,000

PINK: Age, six years; native; last calf, Jan. 23, 1890.

July 12 to Aug. 1, . . . . .	3.25	3.25	3.25	5.00	55.67	—	—	10.06	2.62	1: 6.01	851
Aug. 12 to Sept. 1, . . . . .	3.25	3.25	3.25	5.00	—	61.19	—	10.96	2.71	1: 4.73	876
Sept. 10 to Sept. 30, . . . . .	3.25	3.25	3.25	—	—	—	20.00	8.68	2.99	1: 4.92	873

## FEEDING RECORD—Concluded.

NANCY: Age, seven years; native; last calf, March 16, 1890.

FEEDING PERIODS.		FEED CONSUMED (POUNDS) PER DAY.							Amount of Dry Vegetable Matter contained in the Daily Ration (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
		Corn Meal.	Wheat Bran.	New-process Linseed Meal.	Hay.	Vetch and Oats.	Soya Bean.	Rowen.					
1890.													
July 12 to Aug. 1,	.	3.25	3.25	3.25	4.81	52.48	—	—	25.47	11.23	2.27	1: 5.92	877
Aug. 12 to Sept. 1,	.	3.25	3.25	3.25	5.00	—	54.33	—	27.86	11.42	2.44	1: 4.69	868
Sept. 10 to Sept. 30,	.	3.25	3.25	3.25	—	—	—	19.57	25.57	10.61	2.41	1: 4.90	893
JUNO: Age, seven years; grade, Ayrshire; last calf, June 22, 1889.													
July 12 to Aug. 1,	.	3.25	3.25	3.25	4.71	51.33	—	—	25.11	9.09	2.76	1: 5.88	1,097
Aug. 12 to Sept. 1,	.	3.25	3.25	3.25	5.00	—	55.19	—	28.09	8.67	3.24	1: 4.69	1,104
Sept. 10 to Sept. 30,	.	3.25	3.25	3.25	—	—	—	20.90	26.72	8.16	3.27	1: 4.96	1,139

## TOTAL COST OF FEED PER QUART OF MILK.

*Jessie.*

FEEDING PERIODS.			Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of New-process Linseed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Vetch and Oats consumed (Pounds).	Total Amount of Soybean consumed (Pounds).	Total Amount of Rowen consumed.	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
<b>1890.</b>													
July 12 to Aug. 1,	.	.	151.86	7.23	68.25	68.25	68.25	92.00	1,052.00	—	—	\$4 54	2.99
Aug. 12 to Sept. 1,	.	.	170.35	8.11	68.25	68.25	68.25	105.00	—	1,211.00	—	5 85	3.43
Sept. 10 to Sept. 30,	.	.	159.65	7.60	68.25	68.25	68.25	—	—	—	404.00	5 43	3.40
<b>Roxy.</b>													
July 12 to Aug. 1,	.	.	212.79	10.13	68.25	68.25	68.25	105.00	1,242.00	—	—	\$4 90	2.30
Aug. 12 to Sept. 1,	.	.	209.42	9.97	68.25	68.25	68.25	105.00	—	1,266.00	—	5 98	2.86
Sept. 10 to Sept. 30,	.	.	168.72	8.03	68.25	68.25	68.25	—	—	—	440.00	5 70	3.38
<b>Pink.</b>													
July 12 to Aug. 1,	.	.	211.28	10.06	68.25	68.25	68.25	105.00	1,169.00	—	—	\$4 80	2.27
Aug. 12 to Sept. 1,	.	.	230.12	10.96	68.25	68.25	68.25	105.00	—	1,285.00	—	6 02	2.62
Sept. 10 to Sept. 30,	.	.	182.33	8.68	68.25	68.25	68.25	—	—	—	420.00	5 55	3.04



## TOTAL COST OF FEED PER QUART OF MILK — Concluded.

## Nancy.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of New-process Linseed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Vetch and Oats consumed (Pounds).	Total Amount of Soja Bean consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).

## 1890.

July 12 to Aug. 1	235.93	11.23	68.25	68.25	68.25	101.00	1,102.00	-	-	\$4 68	1.98
Aug. 12 to Sept. 1	239.77	11.42	68.25	68.25	68.25	105.00	-	1,141.00	-	5 70	2.38
Sept. 10 to Sept. 30	222.79	10.61	68.25	68.25	68.25	-	-	-	411.00	5 48	2.46

## June.

July 12 to Aug. 1	190.96	9.09	68.25	68.25	68.25	99.00	1,078.00	-	-	\$4 63	2.42
Aug. 12 to Sept. 1	182.09	8.67	68.25	68.25	68.25	105.00	-	1,159.00	-	5 74	3.15
Sept. 10 to Sept. 30	171.40	8.16	68.25	68.25	68.25	-	-	-	439.00	5 69	3.32

## Pearl.

Aug. 19 to Sept. 4	243.37	14.32	55.25	55.25	55.25	85.00	-	695.00	-	\$4 11	1.69
Sept. 10 to Sept. 30	270.80	13.90	59.95	59.95	59.95	-	-	-	980.00	5 32	1.90

## NET COST OF MILK AND MANURIAL VALUE OF FEED.

*Jessie.*

FEEDING PERIODS.	Total Cost of Feed consumed during Period.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
<b>1890.</b>					Cents.	Pounds.
July 12 to Aug. 1, .	\$4 54	\$2 62	\$2 10	\$2 44	1.61	900
Aug. 12 to Sept. 1, .	5 85	3 30	2 64	3 21	1.88	900
Sept. 10 to Sept. 30, .	5 43	3 13	3 50	2 93	1.84	940
Total, . . .	\$15 82	\$9 05	\$7 24	\$8 58	—	—

*Roxy.*

July 12 to Aug. 1, .	\$4 90	\$2 83	\$2 26	\$2 64	1.24	960
Aug. 12 to Sept. 1, .	5 98	3 37	2 70	3 28	1.57	945
Sept. 10 to Sept. 30, .	5 70	3 28	2 62	3 08	1.83	1,013
Total, . . .	\$16 58	\$9 48	\$7 58	\$9 00	—	—

*Pink.*

July 12 to Aug. 1, .	\$4 80	\$2 76	\$2 21	\$2 59	1.23	865
Aug. 12 to Sept. 1, .	6 02	3 39	2 71	3 31	1.44	880
Sept. 10 to Sept. 30, .	5 55	3 20	2 56	2 99	1.64	874
Total, . . .	\$16 37	\$9 35	\$7 48	\$8 89	—	—

*Nancy.*

July 12 to Aug. 1, .	\$4 68	\$2 70	\$2 16	\$2 52	1.07	880
Aug. 12 to Sept. 1, .	5 70	3 21	2 57	3 13	1.31	870
Sept. 10 to Sept. 30, .	5 48	3 16	2 53	2 95	1.32	905
Total, . . .	\$15 86	\$9 07	\$7 26	\$8 60	—	—

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## NET COST OF MILK AND MANURIAL VALUE OF FEED— *Conclu*

### *Juno.*

FEEDING PERIODS.	Total Cost of Feed consumed during period.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	
<b>1890.</b>					Cents.	P
July 12 to Aug. 1, .	\$4 63	\$2 67	\$2 14	\$2 49	1.30	
Aug. 12 to Sept. 1, .	5 74	3 23	2 58	3 16	1.74	
Sept. 10 to Sept. 30, .	5 69	3 28	2 62	3 07	1.79	
Total, . . .	\$16 06	\$9 18	\$7 34	\$8 72	—	

### *Pearl.*

Aug. 19 to Sept. 4, .	\$4 11	\$2 31	\$1 85	\$2 26	0 93	
Sept. 10 to Sept. 30, .	5 32	3 07	2 45	2 87	1.03	
Total, . . .	\$9 43	\$5 38	\$4 30	\$5 13	—	

## ANALYSES OF MILK.

### *Jessie.*

	July 16.	July 22.	July 29.	Aug. 19.	Aug. 26.	Sept. 16.	Sept. 22.
Solids, . . .	16.23	15.57	15.31	16.36	14.92	14.18	14.51
Fat, . . .	6.87	6.09	6.07	6.18	5.87	5.38	5.35
Solids not fat, .	9.36	9.48	9.24	10.18	9.05	8.80	9.16

### *Roxy.*

Solids, . . .	13.45	13.37	13 00	14.72	14.00	12.43	13.82
Fat, . . .	4.17	4.03	2 63	4 87	4 29	3 32	4 52
Solids not fat, .	9.28	9.34	10 37	9.85	9 71	9.11	9 30

ANALYSES OF MILK—*Concluded.**Pink.*

	July 15.	July 22.	July 29.	Aug. 19.	Aug. 26.	Sept. 16.	Sept. 23.	Sept. 30.
Solids, . . .	15.15	15.26	14.57	15.03	15.57	14.59	15.22	14.82
Fat, . . .	5.19	5.60	5.12	5.17	5.68	5.37	5.89	5.28
Solids not fat, .	9.96	9.66	9.45	9.86	9.89	9.22	9.33	9.54

*Nancy.*

Solids, . . .	13.21	13.29	13.31	13.92	14.18	12.54	13.85	12.61
Fat, . . .	4.22	4.02	4.18	4.56	4.48	4.02	5.14	4.03
Solids not fat, .	8.99	9.27	9.13	9.36	9.70	8.52	8.71	8.58

*Juno.*

Solids, . . .	13.84	13.56	13.94	14.48	14.58	13.39	13.71	13.62
Fat, . . .	4.70	4.13	4.51	4.63	4.73	4.66	4.81	4.53
Solids not fat, .	9.14	9.43	9.43	9.85	9.85	8.73	8.90	9.09

*Pearl.*

Solids, . . .	—	—	—	14.22	13.78	11.36	11.99	11.52
Fat, . . .	—	—	—	4.48	4.45	2.98	3.62	3.23
Solids not fat, .	—	—	—	9.74	9.33	8.38	8.37	8.29

COMPOSITION OF FODDER ARTICLES FED DURING THE PREVIOUS  
DESCRIBED EXPERIMENT.*Corn Meal (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.
Moisture at 100° C., . . .	12.39	247.80	-	-
Dry matter, . . . . .	87.61	1,752.20	-	-
	100.00	2,000.00	-	-
<i>Analysis of Dry Matter.</i>				
Crude ash, . . . . .	1.80	36.00	-	-
“ cellulose, . . . . .	1.80	36.00	12.24	34
“ fat, . . . . .	5.01	100.20	76.15	76
“ protein (nitrogenous matter), . . . . .	10.46	209.20	177.82	85
Non-nitrogenous extract matter, . . . . .	80.93	1,618.60	1,521.48	94
	100.00	2,000.00	1,787.69	-

*New-process Linseed Meal.*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.
Moisture at 100° C., . . .	10.06	201.20	-	-
Dry matter, . . . . .	89.94	1,798.80	-	-
	100.00	2,000.00	-	-
<i>Analysis of Dry Matter.</i>				
Crude ash, . . . . .	6.17	123.40	-	-
“ cellulose, . . . . .	9.22	184.40	47.94	26
“ fat, . . . . .	3.61	72.20	65.70	91
“ protein (nitrogenous matter), . . . . .	37.47	749.40	651.98	87
Non-nitrogenous extract matter, . . . . .	43.53	870.60	792.25	91
	100.00	2,000.00	1,557.87	-

COMPOSITION OF FODDER ARTICLES, ETC.—*Continued.**Wheat Bran.*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	11.52	230.40	-	-	1:3.71
Dry matter, . . . . .	88.48	1,769.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	7.13	142.60	-	-	
“ cellulose, . . . . .	10.63	212.60	42.52	20	
“ fat, . . . . .	5.62	112.40	89.92	80	
“ protein (nitrogenous matter), . . . . .	18.36	367.20	323.14	88	
Non-nitrogenous extract matter, . . . . .	58.26	1,165.20	932.16	80	
	100.00	2,000.00	1,387.74	-	

*Velch and Oats.*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.	
Moisture at 100° C., . . .	76.21	1,524.20	-	-	1: 11.72	
Dry matter, . . . . .	23.79	475.80	-	-		
	100.00	2,000 00	-	-		
<i>Analysis of Dry Matter.</i>						
Crude ash, . . . . .	7.25	145.00	-	-		
“ cellulose, . . . . .	31.73	634.60	-	-		
“ fat, . . . . .	3.37	67.40	33.70	50		
“ protein (nitrogenous matter), . . . . .	7.70	154.00	92.40	60		
Non-nitrogenous extract matter, . . . . .	49.95	999.00	999.00	100		
	100.00	2,000.00	1,125.10	-		

COMPOSITION OF FODDER ARTICLES, ETC. — *Concluded.**Soja Beans.*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	72.95	1,459.00	—	—	} 1:5.43
Dry matter, . . .	27.05	541.00	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . .	11.05	221.00	—	—	
“ cellulose, . . .	24.73	494.60	355.12	71.8	
“ fat, . . .	7.22	144.40	26.28	18.2	
“ protein (nitrogenous matter), . . .	13.64	272.80	174.59	64	
Non-nitrogenous extract matter, . . .	43.36	867.20	527.26	60.8	
	100.00	2,000.00	1,083.25	—	

For analysis of English hay, see preceding feeding records for 1889–90.

#### 4. Creamery Record of the Station for the Years 1889 and 1890.

The cost of feed consumed is based on the market price of the various ingredients, as is stated in the subsequent table.

The valuation of the whole milk is taken at three cents per quart. The estimates of the value of fertilizing ingredients contained in the feed are also based on those given in the following table:—

#### *Local Market Value per Ton of the Various Articles of Fodder used.*

Corn meal, . . . . .	\$23 00
Corn and cob meal, . . . . .	20 70
Wheat bran, . . . . .	21 50
Rye middlings, . . . . .	21 50
Gluten meal, . . . . .	23 00
New-process linseed meal, . . . . .	26 00
Old-process linseed meal, . . . . .	27 00

*Local Market Value per Ton, etc. — Concluded.*

Hay, . . . . .	\$15 00	Soja bean (green), . . .	\$4 40
Rowen, . . . . .	15 00	Vetch and oats (green), .	2 75
Corn fodder, . . . . .	5 00	Vetch (green), . . . . .	3 50
Corn stover, . . . . .	5 00	Serradella (green), . . .	3 16
Corn ensilage, . . . . .	2 25	Cow-pea (green), . . . .	3 14
Millet (dry), . . . . .	12 00	Barley and horse bean	
Lucerne and vetch (dry),	12 00	(green), . . . . .	3 00
Lucerne and clover (dry),	12 00	Potatoes, . . . . .	6 67
Oats (dry), . . . . .	12 00	Carrots, . . . . .	7 00
Oats (green), . . . . .	3 60	Sugar beets, . . . . .	5 00

*Valuation of the Essential Fertilizing Constituents contained in the Various Articles of Fodder used.*

Nitrogen, 16½ cents per pound; phosphoric acid, 6 cents; potassium oxide, 4½ cents.

[Per cent.]

	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Valuation per Ton.
Corn meal, . . . . .	1.86	0.77	0.45	\$7 44
Corn and cob meal, . . . .	1.46	0.603	0.441	5 91
Wheat bran, . . . . .	2.82	3.05	1.49	14 24
Rye middlings, . . . . .	1.84	1.26	0.81	8 27
Gluten meal, . . . . .	5.22	0.40	0.05	17 75
New-process linseed meal, .	6.25	1.42	1.16	23 32
Old-process linseed meal; .	5.33	1.64	1.16	20 54
Hay, . . . . .	1.25	0.464	2.085	6 46
Rowen, . . . . .	1.93	0.364	2.86	9 24
Corn fodder (dry), . . . .	1.37	0.368	0.355	5 26
Corn stover (dry), . . . .	0.78	0.09	0.599	3 19
Corn ensilage, . . . . .	0.36	0.14	0.33	1 64
Millet (dry), . . . . .	1.106	0.38	2.49	6 23
Lucerne and vetch (dry), .	2.02	0.70	2.273	9 44
Lucerne and clover (dry), .	2.06	0.623	1 805	9 08
Oats (dry), . . . . .	1.47	0.51	2.41	7 51
Oats (green), . . . . .	0.33	0.155	0.68	1 85



*Valuation of Essential Fertilizing Constituents, etc. — Con*

	Nitrogen.	Phosphoric Acid.	Potassium Oxide.
Soja bean (green), . . .	0.590	0.193	0.311
Vetch and oats (green), . .	0.23	0.09	0.79
Vetch (green), . . . .	0.49	0.20	0.66
Serradella (green), . . .	0.411	0.14	0.423
Cow-pea (green), . . . .	0.561	0.098	0.306
Barley and beans (green), . .	0.50	0.20	0.40
Potatoes, . . . . .	0.476	0.18	0.56
Carrots, . . . . .	0.14	0.10	0.54
Sugar beets, . . . . .	0.29	0.03	0.18

The value of cream is that granted us from month by our local creamery association. The station has no other connection with the financial management of the creamery.

Our presentation of financial results is based on the cost of feed alone, and does not consider interest on investment and labor involved; for the reason that appropriate estimates on these points are in an exceptional degree dependent on quality of stock, and varying local circumstances. The details are embodied in a few sub-statement tables under the following headings: —

1. Statement of articles of fodder used.
2. Record of average quality of milk and of fodder ration.
3. Value of cream produced at creamery basis of valuation.
4. Cost of skim-milk at the selling price of three cents per quart of whole milk.
5. Fertilizing constituents of cream.
6. Some conclusions suggested by the records.
7. Analyses of cream, and modes of analysis of milk, and butter.



1. *Statement of Articles of Fodder used during 1890 (in Pounds).*

	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-pro-cess Lin-seed Meal.	New-pro-cess Lin-seed Meal.	Cotton-seed Meal.	Hay.	Rowen.	Fodder Corn.	Corn Stover.	Corn Ensilage.	Vetch and Oats.	Soya Beans.	Carrots.	Sugar Beets.
January, .	604.50	604.50	-	604.50	-	-	1,016.00	-	-	-	7,737.50	-	-	-	-
February, .	370.50	546.00	-	529.75	-	-	514.00	-	850.50	-	4,687.50	-	-	1,080.00	-
March, .	-	604.50	-	604.50	-	-	-	-	1,132.00	1,665.00	-	-	-	3,680.00	-
April, .	184.50	577.50	-	106.50	444.00	-	977.00	-	1,201.50	472.50	-	-	-	2,520.00	1,080.00
May, .	604.50	604.50	-	340.50	262.50	-	2,856.50	360.00	-	-	-	-	-	-	3,240.00
June, .	585.00	585.00	-	379.50	204.00	-	-	3,723.50	-	-	-	-	-	-	-
July, .	604.50	604.50	-	-	604.50	-	725.50	613.00	-	-	-	7,463.00	-	-	-
August, .	604.50	604.50	-	-	604.50	-	920.00	-	-	-	-	910.50	8,382.50	-	-
September, .	585.00	585.00	-	-	685.00	-	120.00	2,935.00	-	-	-	-	1,767.00	-	-
October, .	571.50	571.50	-	-	223.50	348.00	-	3,221.50	-	-	-	-	-	-	-





### 3. Value of Cream produced at Creamery Basis of Valuation.

	Total Cost of Feed consumed.	Total Value of Fertilizing Constituents of Food consumed.	Value of Fertilizing Constituents lost in Cream.	Net Cost of Feed for Production of Cream.	Value of Cream produced.
<b>1889.</b>					
January, . . . .	\$52 21	\$21 23	\$0 66	\$31 64	\$40 60
February, . . . .	33 86	19 15	0 63	15 34	36 19
March, . . . .	48 14	21 77	0 75	27 11	42 48
April, . . . .	46 17	23 40	0 78	23 55	42 84
May, . . . .	47 28	27 23	0 83	20 88	39 28
June, . . . .	44 21	23 98	0 72	20 95	33 06
July, . . . .	43 63	25 28	0 76	19 11	34 92
August, . . . .	45 44	27 54	0 76	18 66	36 33
September, . . . .	48 01	28 08	0 73	20 66	38 25
October, . . . .	47 21	23 47	0 71	24 45	39 06
November, . . . .	45 93	22 82	0 66	23 77	36 11
December, . . . .	47 18	24 38	0 67	23 47	36 68
Averages, . . . .	\$45 77	\$24 03	\$0 72	\$22 46	\$37 98
<b>1890.</b>					
January, . . . .	\$37 78	\$23 07	\$0 64	\$15 35	\$33 99
February, . . . .	32 19	19 62	0 69	13 26	36 93
March, . . . .	34 38	19 75	0 66	15 29	37 52
April, . . . .	38 54	19 75	0 68	19 47	32 40
May, . . . .	52 09	25 32	0 73	27 50	33 45
June, . . . .	48 63	30 05	0 72	19 30	30 66
July, . . . .	41 65	23 90	0 68	18 43	29 04
August, . . . .	49 09	27 52	0 73	22 30	39 27
September, . . . .	47 43	28 63	0 72	19 47	42 05
October, . . . .	44 48	27 82	0 65	17 31	39 92
Averages, . . . .	\$42 63	\$24 55	\$0 69	\$18 77	\$35 52

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## 4. Cost of Skim-milk at the Selling Price of Three Cents per Quart for Whole Milk.

	Quarts of Milk produced.	Spaces of Cream.	Quarts of Cream (One Quart equals 3.4 Spaces).	Quarts of Skim-milk.	Value of Cream per Space (Cents).	Value of Cream per Quart of Milk (Cents).	Total Value of Cream.	Cost of Skim-milk per Quart (Whole Milk at Three Cents per Quart).	Total Cost of Skim-milk.
<b>1899.</b>								Cents.	
January, .	1,791.1	1,015	298.5	1,492.6	4.00	2.27	\$40 60	0.88	\$13 13
February, .	1,680.0	965	283.8	1,396.2	3.75	2.15	36 19	1.02	14 21
March, . .	1,895.0	1,148	337.6	1,557.4	3.70	2.24	42 48	0.92	14 37
April, . .	1,931.6	1,190	350.0	1,581.6	3.60	2.22	42 84	0.96	15 11
May, . . .	2,025.2	1,267	372.6	1,652.6	3.10	1.94	39 28	1.30	21 48
June, . . .	1,785.6	1,102	324.1	1,461.5	3.00	1.85	33 06	1.40	20 51
July, . . .	2,001.2	1,164	342.4	1,658.8	3.00	1.74	34 92	1.51	25 12
August, . .	1,991.9	1,172	344.7	1,647.2	3.10	1.82	36 33	1.42	23 43
September, .	1,856.0	1,125	330.9	1,523.1	3.40	2.06	38 25	1.14	17 43
October, . .	1,665.0	1,085	319.1	1,345.9	3.60	2.35	39 06	0.81	10 89
November, .	1,538.1	1,003	295.0	1,243.1	3.60	2.35	36 11	0.81	10 03
December, .	1,463.8	1,019	299.7	1,164.1	3.60	2.51	36 68	0.62	7 23
Averages, .	1,802.0	1,103	324.9	1,477.2	3.45	2.13	\$37 98	1.07	\$16 08
<b>1890.</b>									
January, . .	1,404.1	971	285.6	1,118.5	3.50	2.42	\$33 99	0.73	\$3 13
February, . .	1,596.2	1,055	310.3	1,285.9	3.50	2.31	36 93	0.85	10 96
March, . . .	1,594.8	1,014	298.2	1,296.6	3.70	2.35	37 52	0.80	10 32
April, . . .	1,720.8	1,035	304.4	1,416.4	3.13	1.88	32 40	1.36	19 22
May, . . . .	1,946.7	1,115	327.9	1,618 8	3.00	1.72	33 45	1.54	24 95
June, . . . .	1,922.4	1,095	322.1	1,600.3	2.80	1.59	30 66	1.69	27 01
July, . . . .	1,727.0	1,037	305.0	1,422.0	2.80	1.68	29 04	1.60	22 77
August, . . .	1,809.5	1,122	330.0	1,479.5	3.50	2.17	39 27	1.02	15 02
September, .	1,747.4	1,098	322.9	1,424.5	3.83	2.41	42 05	0.73	10 37
October, . . .	1,556.9	998	293.5	1,263.4	4.00	2.56	39 92	0.54	6 79
Averages, . .	1,702.6	1,054	310.0	1,392.6	3.38	2.11	\$35 52	1.09	\$16 55

## 5. Fertilizing Constituents of Cream.

[Average analysis.]

	Per Cent.
Moisture at 100° C., . . . . .	75.22
Nitrogen (16½ cents per pound), . . . . .	.54
Potassium oxide (4½ cents per pound), . . . . .	.123
Phosphoric acid (6 cents per pound), . . . . .	.168

### 6. *Conclusions.*

1. The nutritive ratio of the feed in 1889 varied from 1 : 4.70 to 1 : 6.57, with an average of 1 : 5.88 ; it varied in 1890 from 1 : 4.64 to 1 : 6.25, with an average of 1 : 5.25.

2. The amount of fat in the milk varied, during the year 1889, from 3.90 per cent. to 4.72 per cent., average 4.39 per cent. In 1890 it varied from 4.38 per cent. to 4.99 per cent., with an average of 4.63 per cent.

3. The total solids varied, in 1889, from 13.82 per cent. to 14.49 per cent., average 14.12 per cent. In 1890 it ran from 13.37 per cent. to 14.65 per cent., average 13.88 per cent.

4. Total cost of feed for one quart of cream amounts, in 1889, to 14.09 cents, and in 1890 to 13.75 cents.

5. Net cost of feed for one quart of cream amounts, in 1889, to 6.09 cents, and in 1890 to 6.05 cents.

6. The value received for one space of cream varied, in 1889, from 3 to 4 cents, with an average of 3.43 cents. In 1890 it varied from 2.80 to 4 cents, with an average of 3.38 cents, which amounts, per quart, in 1889 to 11.69 cents, and in 1890 to 11.46 cents.

7. The quantity of milk, in quarts, required to produce one space of cream, in 1889, amounted to 1.63, and 1.62 in 1890, or 5.54 quarts of whole milk to produce one quart of cream in 1889, and 5.49 quarts in 1890.

8. The net cost of feed per quart of cream averages, in 1889, 6.9 cents, and in 1890 6.05 cents. We received per quart of cream, in 1889, 11.69 cents, and in 1890 11.46 cents, thereby securing a profit of 4.79 cents in 1889, and 5.41 cents in 1890.

From these statements it appears, as has already been claimed in previous reports, that close fodder rations tend to improve the quality of the milk, as well as the condition of the animal.

For further details concerning results in preceding years, see pages 82 to 84, seventh annual report.

Our average statements for the current year apply in each case to only ten months, due to the fact that financial settlement with our local creamery is made two months after cream is furnished.



*7. Creamery Record, 1890. — Analyses of Cream and Butter Fat.*

DATE OF SAMPLING.	ANALYSIS OF CREAM.			DATE OF TESTING.	ANALYSIS OF FAT.		AVERAGE DAILY FODDER RATION.
	Solids.	Fat.	Solids not Fat.		Vola- tile Acids.	Non- volatile Acids.	
1890.				1890.			
January 23,	27.02	18.65	8.97	January 23,	6.55	86.93	3½ pounds corn meal, 3½ pounds wheat bran, 3½ pounds old-pro- cess linseed meal, 5 pounds hay, 50 pounds corn en- silage.
" 24,	27.85	17.80	10.05	" 24,	6.63	87.10	
" 27,	25.08	17.30	7.68	" 27,	6.29	87.99	
February 3,	27.52	19.20	8.32	February 3,	6.61	88.92	
" 5,	25.80	18.31	7.49	" 5,	6.53	88.18	
" 11,	27.70	18.43	9.27	" 11,	6.40	88.60	
February 24,	26.47	20.96	5.51	February 24,	6.12	89.20	3½ pounds wheat bran, 3½ pounds old-process lin- seed meal, 20 pounds carrots, 18 pounds fodder corn.
" 26,	25.18	16.52	8.66	" 26,	6.37	89.02	
March 3,	25.10	16.02	8.48	March 3,	6.44	88.84	
" 6,	26.38	18.14	8.24	" 6,	6.38	88.92	
" 10,	25.40	17.82	7.58	" 10,	6.38	88.90	
" 11,	26.10	18.24	7.86	" 11,	6.32	88.94	
April 30,	23.30	14.51	8.79	April 30,	6.57	87.10	3½ pounds wheat bran, 3½ pounds corn meal, 3½ pounds new-pro- cess linseed meal, 20 pounds sugar beets, 15 pounds hay.
May 2,	24.67	16.37	8.36	May 2,	6.44	88.31	
" 5,	26.05	17.49	8.56	" 5,	6.35	87.58	
" 7,	23.93	15.00	8.93	" 7,	6.62	88.49	
" 9,	24.72	15.94	8.78	" 9,	6.45	87.39	
" 12,	24.88	14.96	9.92	" 12,	6.52	88.10	
May 20,	25.12	16.90	8.22	June 25,	6.54	88.02	3½ pounds corn meal, 3½ pounds wheat bran, 3½ pounds old-pro- cess linseed meal, 20 pounds sugar beets, 15 pounds hay.
" 21,	25.76	17.46	8.30	" 28,	6.48	87.90	
" 23,	26.69	19.18	7.51	July 20,	7.50	84.76	
" 26,	25.61	17.52	8.09	" 22,	7.96	82.04	
" 28,	24.42	16.35	8.07	" 24,	8.11	78.69	
June 6,	25.76	17.95	7.81	July 28,	7.44	83.56	3½ pounds corn meal, 3½ pounds wheat bran, 3½ pounds old-pro- cess linseed meal, 20 pounds rowen.
" 9,	27.70	19.86	7.84	August 1,	7.37	85.35	
" 12,	26.00	18.26	7.74	" 3,	8.06	82.99	
" 13,	26.26	18.38	7.88	September 16,	7.21	83.55	
June 17,	24.53	17.93	6.60	September 19,	6.75	86.59	3½ pounds corn meal, 3½ pounds wheat bran, 3½ pounds old-pro- cess linseed meal, 20 pounds rowen.
" 18,	25.54	17.67	7.87	" 23,	6.61	86.40	

## 7. Creamery Record, 1890 — Concluded.

DATE OF SAMPLING.	ANALYSIS OF CREAM.			DATE OF TESTING.	ANALYSIS OF FAT.		AVERAGE DAILY FODDER RATION.
	Solids.	Fat.	Solids not Fat.		Volatile Acids.	Non-volatile Acids.	
1890.				1890.			
June 27,	24.30	17.34	6.96	September 30,	6.99	86.23	3½ pounds corn meal, 3½ pounds wheat bran, 3½ pounds new-process linseed meal, 20 pounds rowen.
" 29,	25.59	18.01	7.58	-	-	-	
July 2,	24.83	17.02	7.86	October 7,	6.74	86.68	
" 3,	22.94	15.97	6.97	" 9,	6.94	86.47	
July 29,	23.61	16.37	7.24	August 7,	6.78	86.61	3½ pounds corn meal, 3½ pounds wheat bran, 3½ pounds new-process linseed meal, 5 pounds hay, 45 pounds vetch and oats.
August 1,	21.32	14.85	6.47	" 11,	6.78	87.14	
August 20,	26.14	18.84	7.30	August 20,	6.70	87.34	3½ pounds corn meal, 3½ pounds wheat bran, 3½ pounds new-process linseed meal, 5 pounds hay, 50 pounds soja bean.
" 27,	26.44	19.07	7.27	" 27,	6.35	87.92	
September 5,	26.72	19.37	7.35	September 5,	6.25	88.40	
September 17,	24.20	16.97	7.23	September 17,	6.39	87.49	3½ pounds corn meal, 3½ pounds wheat bran, 3½ pounds new-process linseed meal, 20 pounds rowen.
" 24,	22.07	14.87	7.20	" 24,	6.43	86.99	
November 7,	24.12	15.46	8.66	November 12,	7.36	86.35	3 pounds corn meal, 3 pounds wheat bran, 3 pounds cotton-seed meal, 20 pounds rowen.
" 12,	25.18	16.42	8.76	" 12,	6.94	87.04	
" 19,	25.15	15.96	9.19	" 19,	7.06	84.84	
December 2,	-	-	-	December 2,	6.10	84.35	3 pounds corn meal, 3 pounds wheat bran, 3 pounds gluten meal, 18 pounds rowen.
" 9,	26.17	17.21	8.96	" 9,	6.48	86.45	
" 16,	21.30	13.63	7.67	" 16,	6.87	85.50	
December 24,	25.95	17.29	8.66	December 24,	6.71	85.40	3 pounds corn meal, 3 pounds wheat bran, 3 pounds old-process linseed meal, 17 pounds rowen.
" 30,	24.78	16.32	8.46	" 30,	6.61	85.23	

The analyses of samples taken prior to May 20 were made according to the method of R. W. Moore, as modified by Waller. Those analyzed subsequent to that date were made according to the method of L. F. Nilson, as described in this report, on page 68.

*Method of Milk Analysis.*

*Total Solids.* — Evaporate a known quantity of milk (approximately 5 grams) in a weighed porcelain dish, containing 15 to 20 grams of pure, dry sand, on the water bath until apparently dry, then transfer to the air bath and dry at 100° to 105° C. to a constant weight, weighing at intervals of about an hour. In case of cream, use 2.5 to 3 grams for evaporation.

*Fat.* — Pulverize the sand containing the solids without removing from the dish, subsequently transfer to a filter, and exhaust with anhydrous, alcohol-free ether. Dry the fat obtained on the evaporation of the ether in an air bath at 100° to 105° C. to a constant weight.

*Ash.* — A weighed quantity of milk is evaporated to dryness with a few drops of nitric acid, and burned in a muffle at a low red heat until free from carbon.

*Methods of Butter Analysis.*

(1) *Moisture.* — Two and five-tenths to 3 grams are dried at 100° C. in an air bath.

(2) *Salt.* — Six to 7 grams of the butter are washed into a separatory funnel with hot water, and are well shaken, and allowed to stand until the fat has collected on top; the water is then drawn off, and a fresh quantity added, and shaken up with the butter. This is continued until 200 to 300 cubic centimetres of water have passed through the funnel. The washings are mixed, and made up to 500 cubic centimetres, and the chlorine determined in an aliquot part by means of silver nitrate. From the chlorine the salt is readily calculated.

(3) *Fat.* — Two and five-tenths to 3 grams of the fat freed from salt by the above operation (2), and from water by drying in the air bath, are dissolved in ether, and filtered from the curd into a tared flask. The ether is driven off, and the residual fat dried and weighed. In calculating the per cent., allowance is made for salt and water removed.

(4) *Casein.* — The residue remaining on the filter in (3) is tested for nitrogen by the Kjeldahl method. The factor 6.33 is used in reducing the per cent. of nitrogen found to casein.

*Method for determining Volatile and Non-volatile Fatty Acids  
(first).*

Directly after receiving the sample of cream from the Cooley cream-setting apparatus, the solids and fat were determined as usual. The cream was churned by vigorous shaking in a bottle, and was washed several times with cold water. The butter was then dissolved in ether, filtered from the curd, and the ether evaporated. About 2.5 grams of fat were placed in a weighed Erlenmeyer flask, the exact weight taken, and the fat saponified by 1 gram of potassium hydrate dissolved in 50 cubic centimetres of 70 per cent. alcohol. Heat is necessary for complete saponification. The alcohol is next driven off by continued heating in a boiling-water bath. The resulting soap is dissolved in 50 cubic centimetres of water, and decomposed by means of 20 cubic centimetres of dilute sulphuric acid (1 part of strong acid to 10 of water); 50 cubic centimetres are then distilled off, using a condenser for that purpose, the distillate passing through a filter. The distillate is titrated with one-tenth-normal sodium hydrate solution (4 grams of pure sodium hydrate per litre of water), 50 cubic centimetres of water are added to the contents of the flask, and an equal quantity distilled off, which is titrated as before. This treatment is continued until .1 cubic centimetre or less of the soda solution is required for neutralization. Phenolphthalein is used as an indicator. The volatile fatty acids are calculated from the sum of the cubic centimetres of soda solution required to neutralize all the distillates, calculating the acid as butyric. After cooling, the liquid remaining in the flask is poured off from the solidified non-volatile fatty acids through the same filter used in filtering the distillates. The solid fatty acids are washed repeatedly with hot water, until all traces of sulphuric acid are removed. The condenser is then washed out with hot alcohol, and the filter exhausted with the same solvent, the washings being collected in the flask. The alcohol is then driven off, the flask and contents dried at 100° C., and weighed, and the per cent. of non-volatile fatty acids calculated. The above method is that of R. W. Moore, as modified by Waller, and described in the "Journal of the American Chemical Society," No. 9, 1889, by R. W. Moore.

*Method for determining Volatile and Non-volatile Fatty Acids contained in Butter (second).*

The sample is prepared by churning the cream in a suitable bottle, washing the butter well with cold water, melting at 50° C. and filtering from the curd through a hot-water funnel. The fat is then heated in the air bath until free from water.

The method pursued in the determination of the volatile and non-volatile fatty acids is essentially that described by L. F. Nilson, in "Zeit. f. Anal. Chemie," 28, 2, 176.

Two and eight-tenths cubic centimetres to 2.9 cubic centimetres (approximately 2.5 grams) are measured into a tared Erlenmeyer flask of 250 cubic centimetres capacity, and the exact weight determined.... Saponification is accomplished by adding 1 gram of potassium hydrate dissolved in 2 cubic centimetres of water, and 5 cubic centimetres of strong (95 per cent.) alcohol. The flask is provided with a reflux condenser, and heated until saponification is complete. The alcohol is then driven off, the last traces being removed by means of the following device: the flask is provided with a double perforated rubber cork, one hole carrying a glass tube reaching nearly to the bottom of the flask and provided above with a short rubber tube carrying a pinch-cock, the other connected by means of a rubber tube with a suction pump. By alternately opening and closing the pinch-cock while the pump is working, the last traces of alcohol can be readily removed from the soap.

Dissolve the soap thus obtained in 30 cubic centimetres of warm water, decompose with 20 cubic centimetres of a 20 per cent. solution of orthophosphoric acid, distil off the volatile acids through a condenser, filtering the distillate, and titrate with decinormal sodium hydrate, using phenolphthalein as indicator. The volatile acids are expelled from the flask by a current of steam. When the distillate amounts to 500 cubic centimetres, the operation is considered to be complete. The volatile acids are calculated as butyric.

The condenser and connections are rinsed back into the flask with boiling water, and the non-volatile acids washed with hot water, and filtered when cool through the same filter

that was used for the distillate. The washing is continued until no traces of phosphoric acid are left in the distillate. The filter is then exhausted with hot alcohol, allowing the solution to run into the flask. The alcohol is driven off on the water bath, and the non-volatile fatty acids dried at 100° C. in the air bath until they begin to gain weight.

*Dairy Salt, 1890.*

[Sent on from the Cummington Creamery.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	0.880	0.320	0.295
Sodium chloride, . . . . .	97.877	98.009	98.513
Calcium chloride, . . . . .	0.016	0.013	0.010
Calcium sulphate, . . . . .	1.108	1.644	1.160
Magnesium chloride, . . . . .	0.010	0.014	0.012
Magnesium oxide, . . . . .	0.007	—	—
Insoluble matter, . . . . .	0.102	0.020	0.010

*Dairy Salt, 1890.*

[I. and II. sent on from Amherst, Mass.; III. and IV. sent on from Northampton, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C., . . . . .	0.235	0.200	0.855	0.565
Sodium chloride, . . . . .	98.563	98.575	98.891	97.935
Calcium sulphate, . . . . .	1.137	1.185	0.906	1.376
Calcium chloride, . . . . .	0.045	0.029	0.293	0.097
Magnesium chloride, . . . . .	0.020	0.007	0.055	0.027
Magnesium oxide, . . . . .	—	0.004	—	—
Insoluble matter, . . . . .	—	—	—	—

A good dairy salt ought to be of a uniform, fine granulation, of a white color, free from colored specks, free from any odor, of a pure saline test and of a neutral reaction. The chlorides of calcium and magnesia should not exceed one-tenth of one per cent.

## II. — FEEDING EXPERIMENTS WITH LAMBS, 1890.

The feeding experiments which are briefly described within a few subsequent pages are the first of a series devised for the purpose of ascertaining the cost of feed, when fattening lambs, by means of winter fodder rations, for the meat market.

The selection of animals, with reference to breeds best adapted for our purpose, was controlled by the temporary supply of our local market. Six lambs, three ewes and three wethers, bought of a farmer in our vicinity, Sept. 4, 1889, served for our observations. They were grades of a somewhat doubtful parentage; five showed some of the characteristics of Hampshire Downs, and one of Merinos. Each animal occupied, during the entire period of observation, a separate pen. They were shorn before being weighed, at the beginning of the experiment.

The daily diet of the entire lot consisted, during the first week, of rowen (dried second cut of grass lands). They were subsequently treated in two divisions, each comprising three animals. This division was made for the purpose of comparing the effect of two distinctly different daily fodder rations on the financial results of the operation. Division I. (Nos. 1-3) received a daily diet much richer in nitrogenous food constituents than the one adopted for Division II. (Nos. 4-6). This circumstance was brought about by feeding to the first division as grain feed a mixture of wheat bran and of gluten meal, and to the second division one consisting of a liberal proportion of corn meal, with some wheat bran and gluten meal. The coarse portion of the daily feed was in both cases essentially the same; namely, either rowen, or rowen and corn ensilage, or corn ensilage alone. It was cut before being mixed with the grain feed, when fed. The daily fodder ration was divided into two equal parts, and fed respectively in the morning and in the evening. The amount of feed left unconsumed, if any, was collected each morning and deducted from the daily ration offered the preceding day for consumption.

The observations in case of the first division of lambs (Nos. 1-3) were continued for 152 successive days (Sept.

5, 1889, to Feb. 4, 1890), while in case of the second division (Nos. 4-6) they were extended to March 18, 1890, and lasted thus for 194 consecutive days. Low rate of increase in live weight and local market condition advised the extension of the trial in the latter case.

The three lambs of the first division gained within 152 days, in live weight, in the aggregate  $107\frac{1}{2}$  pounds, or each individual on an average  $35\frac{5}{8}$  pounds; while those of the second division (Nos. 4-6) gained during 194 days, in the aggregate, only 86 pounds, or each individual on an average  $28\frac{2}{3}$  pounds.

Some of the essential points of interest in the experiment here under discussion are stated in some subsequent pages, under the following headings:—

1. Weight of lambs.
2. Cost of lambs.
3. Character and cost of feed consumed.
4. Gain in live weight during the observation.
5. Financial statement.
6. Conclusion.
7. Detailed statement of feeding record.

### *1. Weight of Lambs.*

The aggregate live weight of six lambs when bought amounted to  $450\frac{1}{2}$  pounds.

The wool secured before the beginning of the feeding experiments amounted to  $22\frac{1}{4}$  pounds.

	Live Weights when bought.	Wool removed.	Live Weights at the Beginning of Trial.
1, .	82.50 pounds.	3.50 pounds.	79.00 pounds (wether).
2, .	69.50 pounds.	3.50 pounds.	66.00 pounds (ewe).
3, .	75.00 pounds.	4.25 pounds.	70.75 pounds (ewe).
4, .	71.00 pounds.	3.50 pounds.	67.50 pounds (ewe).
5, .	70.00 pounds.	3.75 pounds.	66.25 pounds (wether).
6, .	82.50 pounds.	3.75 pounds.	78.75 pounds (wether).
	450.50 pounds.	22.25 pounds.	428.25 pounds.



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Division I. consisted of lambs Nos. 1-3; its aggregate live weight was 215.75 pounds at the beginning of the experiment.

Division II. consisted of lambs Nos. 4-6; its aggregate live weight at the beginning of the experiment was 212.50 pounds.

### 2. *Cost of Lambs.*

The entire lot was bought at six cents per pound of live weight, and the sum paid for 450.5 pounds of the original weight amounted to \$27.03.

The wool secured before the beginning of the feeding trial, which amounted to 22.25 pounds, was returned at 23 cents per pound. The sum realized by that transaction was \$5.12. Allowing the deduction of \$5.12 on the first cost of the lambs, which was \$27.03, it will be found that their actual cost at the beginning of the experiment was but \$21.91, or 5.12 cents per pound of live weight. The live weight without the removed wool was 428.25 pounds.

#### *Division I.*

1. 79.00 pounds of live weight, at 5.12 cents,	.	.	\$4 05	} \$11 01
2. 66.00 pounds of live weight, at 5.12 cents,	.	.	3 38	
3. 70.00 pounds of live weight, at 5.12 cents,	.	.	3 58	

#### *Division II.*

4. 67.00 pounds of live weight, at 5.12 cents,	.	.	\$3 43	} \$10 85
5. 66.25 pounds of live weight, at 5.12 cents,	.	.	3 39	
6. 78.75 pounds of live weight, at 5.12 cents,	.	.	4 03	

### 3. *Character and Cost of the Feed consumed.*

To secure a normal and uniform condition of the animals selected for a comparative test of different fodder rations, with reference to their influence on the financial results of the operation, nothing but rowen was fed to the entire lot for ten days preceding the experiment (September 4 to September 16). Subsequently a division of animals was made. Three lambs, 1-3, were fed with daily rations richer in digestible nitrogenous food constituents than those fed to the remaining number, 4-6.

The daily feed of the first division (1-3) contained on an average from 4.5 to 5.5 parts of digestible non-nitrogenous

food constituents to one part of digestible nitrogenous food constituents, 1 : 4.5 to 1 : 5.5.

The daily diet of the second division (4-6) contained, during a corresponding period of the feeding experiment, one part of digestible nitrogenous food constituents to from 6.99 to 7.3 parts of digestible non-nitrogenous food constituents, 1 : 6.99 to 1 : 7.3. Subsequently a diet similar to that adopted for the first division was substituted.

*Fodder Combinations used in Division I. (1-3).*

The daily quantity of the subsequently stated fodder rations was regulated by the appetite of each animal.

*a. September 16 to September 30 :—*

Two pounds of rowen, 1 pound of a mixture consisting of wheat bran, 2 weight parts ; gluten meal, 1 weight part.

Nutritive ratio, 1 : 4.75.

*b. October 1 to December 31 :—*

Two pounds of rowen, 1 pound of a mixture consisting of wheat bran and gluten meal, equal weights.

Nutritive ratio, 1 : 4.55.

*c. January 2 to January 20 :—*

One pound of rowen,  $3\frac{1}{2}$  pounds of corn ensilage, 1 pound of the same grain mixture as in ration *b*.

Nutritive ratio, 1 : 5.09.

*d. January 21 to February 3 :—*

Seven pounds of corn ensilage, 1 pound of grain mixture as in ration *b*.

Nutritive ratio, 1 : 5.5.

*Cost of Above Fodder Rations for Weights stated.*

	<i>a.</i>	<i>b.</i>	<i>c.</i>	<i>d.</i>
Total cost of feed consumed (cents), . . .	2.45	2.51	2.24	1.97
Manurial value obtainable (cents), . . .	1.13	1.15	1.10	1.04
Net cost of feed (cents), . . . . .	1.32	1.36	1.14	0.93

*Fodder Combinations used in Division II. (4-6).*

*a. September 16 to December 31 :—*

Two pounds of rowen,  $\frac{1}{2}$  pound of a mixture consisting of corn meal, 10 weight parts ; wheat bran, 2 weight parts ; gluten meal, 1 weight part.

Nutritive ratio, 1 : 7.00.

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### b. January 2 to January 20 : —

One pound of rowen,  $3\frac{1}{2}$  pounds of corn ensilage,  $\frac{1}{2}$  pound of the same grain mixture as in preceding ration *a*.

Nutritive ratio, 1 : 7.3.

### c. February 4 to February 15 : —

Six pounds of corn ensilage, 1 pound of a mixture consisting of wheat bran and gluten meal, equal weights.

Nutritive ratio, 1 : 5.7.

### d. February 18 to March 17 : —

One and one-half pounds of corn fodder, 1 pound of a mixture the same as in ration *c*.

Nutritive ratio, 1 : 4.88.

### *Cost of Fodder Rations used in Division II.*

	<i>a.</i>	<i>b.</i>	<i>c.</i>	<i>d.</i>
Total cost of feed consumed (cents), . . . . .	1.98	1.71	1.83	1.56
Manurial value obtainable (cents), . . . . .	0.71	0.50	0.97	0.89
Net cost of feed (cents), . . . . .	1.27	1.21	0.86	0.67

The customary deduction of twenty per cent. of the manurial value of the feed consumed is adopted in the above valuation. Net cost of feed represents its first cost, or local market value, less eighty per cent. of the market value of its manurial constituents.

### *Cost of Fodder Articles used in the Experiment.*

Rowen, per ton, . . . . .	\$15 00
Corn ensilage, per ton, . . . . .	2 75
Corn meal, per ton, . . . . .	19 00
Wheat bran, per ton, . . . . .	17 00
Gluten meal, per ton, . . . . .	23 00

## 4. Gain in Live Weight during the Experiment.

*Division I. (1-3). Time of Observation extended over 152 Days.*

	Live Weight at the Beginning of the Experiment (Pounds).	Live Weight at the Time of Killing before shearing (Pounds).	Gain in Live Weight during the Experiment (Pounds).
One, . . . . .	79.00	118 25	39.25
Two, . . . . .	66.00	98.50	32.50
Three, . . . . .	70 75	106.50	35.75
	215.75	323 25	107.50

*Division II. (4-6). Time of Observation extended over  
194 Days.*

	Live Weight at the Beginning of the Experiment (Pounds).	Live Weight at the Time of Killing before shearing (Pounds).	Gain in Live Weight during the Experiment (Pounds).
Four, . . . . .	67.50	102.50	35.00
Five, . . . . .	66.25	86.50	20.50
Six, . . . . .	78.75	109.50	30.75
	212.50	298.50	86.25

Division I., entire lot gained in live weight on an average per day, 0.706 pounds.

Division II., entire lot gained in live weight on an average per day, 0.445 pounds.

*The Amount of Raw Wool secured after the Close of the  
Experiments. Division I. (1-3).*

	Live Weight, with Wool.	Live Weight after shearing.	Amount of Wool obtained.	
	Pounds.	Pounds.	Pounds.	Ounces.
One, . . . . .	118.25	114.38	3	14
Two, . . . . .	98.50	94.60	3	15
Three, . . . . .	106.50	102.00	4	8
	323.25	310.98	12	5

*Division II. (4-6).*

	Live Weight, with Wool.	Live Weight after shearing.	Amount of Wool obtained.	
	Pounds.	Pounds.	Pounds.	Ounces.
Four, . . . . .	102.50	99.25	3	4
Five, . . . . .	86.50	82.00	4	8
Six, . . . . .	109.50	105.00	4	8
	298.50	286.25	12	4

Division I. yielded 12 pounds, 5 ounces of wool.

Division II. yielded 12 pounds, 4 ounces of wool.

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The former is the result of 152 days of growth, and the latter that of 194 days. Lamb No. 5 is a Merino grade; the remainder are Hampshire Down grades.

### 5. Financial Statement.

The wool was sold at 23 cents per pound, the pelts brought  $12\frac{1}{2}$  cents each.

#### Division I. (1-3).

The difference between the live weights of the animals at the close of the experiment, after shearing, and the dressed lambs, when sold, amounted on an average to 44.3 per cent.

#### Yield Dressed Weights.

1.	66 pounds, at 11 cents per pound,	.	.	.	\$7 26
2.	54 pounds, at 11 cents per pound,	.	.	.	5 94
3.	60 pounds, at 11 cents per pound,	.	.	.	6 60
	<u>180 pounds,</u>	.	.	.	<u>\$19 80</u>

#### Division II. (4-6).

The difference between the live weights of the animals at the close of the experiment, after shearing, and the dressed lambs, when sold, amounted on an average to 46.3 per cent.

#### Yield Dressed Weights.

4.	54 pounds, at 11 cents per pound,	.	.	.	\$5 94
5.	46 pounds, at 11 cents per pound,	.	.	.	5 06
6.	60.50 pounds, at 11 cents per pound,	.	.	.	6 65
	<u>160.50 pounds,</u>	.	.	.	<u>\$17 65</u>

#### Division I.

	1.	2.	2.	
Cost of lamb, . . . .	\$4 05	\$3 38	\$3 58	\$22 78
Cost of feed consumed, . . . .	4 58	3 11	4 08	
	<u>\$8 63</u>	<u>\$6 49</u>	<u>\$7 66</u>	
Value received for meat, . . . .	\$7 26	\$5 94	\$6 60	\$28 70
Value received for wool and pelt, . . . . .	1 02	1 04	1 17	
Value of obtainable manure, . . . .	2 19	1 52	1 96	
	<u>\$10 47</u>	<u>\$8 50</u>	<u>\$9 73</u>	

Difference in favor, \$5.92.

*Division II.*

	4.	5.	6.	
Cost of lamb, . . . . .	\$3 43	\$3 39	\$4 03	} \$22 34
Cost of feed consumed, . . . . .	4 64	3 03	3 82	
	<hr/>	<hr/>	<hr/>	
	\$8 07	\$6 42	\$7 85	
Value received for meat, . . . . .	\$5 94	\$5 06	\$6 65	} \$25 37
Value received for wool and pelt, . . . . .	0 89	1 17	1 17	
Value of obtainable manure, . . . . .	1 71	1 23	1 55	
	<hr/>	<hr/>	<hr/>	
	\$8 54	\$7 46	\$9 37	

Difference in favor, \$3.03.

*6. Conclusions.*

1. The well-established superior feeding effect of a daily diet rich in digestible nitrogenous food constituents, when raising lambs for the meat market, is shown in a marked degree in Division I., as compared with those in Division II.

2. The good services of the particular fodder rations used in case of the first division of lambs is shown by a fair rate of increase in live weight.

3. Corn ensilage as a substitute in part for rowen has given very satisfactory results.

4. The profit obtained with reference to both divisions of lambs is due to the commercial value of the fertilizing constituents contained in the obtainable manure. This value amounts in the case of the first division of lambs to \$5.67. To appreciate this value properly, it needs to be considered that, in determining the financial results of the experiment, all home-raised fodder articles are counted on the basis of their retail selling price in our vicinity. Sheep are known to produce one of the best home-made manures.

The decidedly beneficial influence of a rational and liberal system of stock-feeding on the financial results of a mixed farm management cannot find *its full expression* in the mere presentation of the results of a feeding experiment, however carefully the matter may be arranged.

## 7. Detailed Statement of Feeding Record.

## Sheep No. 1.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.				Pounds of Dry Matter In Daily Fodder consumed.	Gain In Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Gluten Meal.	Rowen.	Corn Ensilage.					
1889-1890.									
Sept. 17 to Sept. 30, .	0.74	0.37	1.93	-	2.67	0.32	8.34	1: 4.74	86.00
Oct. 1 to Dec. 3, .	0.69	0.69	2.52	-	3.43	0.26	13.19	1: 4.55	96.75
Dec. 17 to Dec 31, .	0.75	0.75	2.87	-	3.84	0.30	12.80	1: 4.59	111.00
Jan. 2 to Jan. 20, .	0.77	0.77	1.54	4.05	3.82	0.26	14.69	1: 5.09	114.50
Jan. 21 to Feb. 3, .	0.63	0.63	-	6.29	2.84	0.02	142.00	1: 5.52	117.50

*Total Amount of Feed consumed from Sept. 5, 1889, to Feb. 3, 1890.\**

	Dry Matter (Pounds).	Cost.	Fertilizer Value.
104.57 pounds wheat bran, . . .	94.88	\$0 89	\$0 71
97.07 pounds gluten meal, . . .	87.56	1 12	0 79
310.00 pounds rowen, . . .	268.05	2 33	1 07
178.50 pounds corn ensilage, . . .	48.42	0 24	0 15
	498.91	\$4 58	\$2 72

\* Includes the feed during the 12 days preceding the experiment proper.

	Pounds.
Live weight of animal at beginning of experiment, . . .	79.00
Live weight at time of killing, . . .	118.25
Live weight gained during experiment, . . .	39.25
Average gain in weight per day, . . .	0.25
Dressed weight of animal, . . .	66.00
Loss in weight by dressing, . . . 52.25 pounds, or 44.19 per cent.	
Pounds of dry matter fed to produce 1 pound of live weight, . . .	12.71
Cost of feed per pound of live weight gained, . . .	11.67 cents
Net cost of feed per pound gained after deducting 20 per cent. of manurial value, . . .	6.11 cents.

## 7. Detailed Statement of Feeding Record—Continued.

## Sheep No. 1.

FEEDING PERIODS.	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Nutritive Ratio of Feed.	Live Weight of Animal at Beginning of Period (Pounds).	Live Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1889-1890.</b>								
Sept. 17 to Sept. 30, .	10.33	5.17	27.00	-	1:4.74	84.00	88.50	0.32
Oct. 1 to Dec. 3, .	44.31	44.31	161.00	-	1:4.55	88.50	105.00	0.26
Dec. 17 to Dec. 31, .	11.25	11.25	43.00	-	1:4.59	108.00	112.50	0.30
Jan. 2 to Jan. 20, .	14.63	14.63	29.25	77.00	1:5.09	113.00	118.00	0.26
Jan. 21 to Feb. 3, .	8.88	8.88	-	88.00	1:5.52	118.00	118.25	0.02

## Total Amount of Feed consumed from Sept. 17, 1889, to Feb. 3, 1890.

	Pounds.
99.90 pounds wheat bran, equal to dry matter, . . .	90.64
94.74 pounds gluten meal, equal to dry matter, . . .	85.46
281.00 pounds rowen, equal to dry matter, . . .	242.98
178.50 pounds corn ensilage, equal to dry matter, . . .	48.42
Total amount of dry matter, . . . . .	467.50

	Pounds.
Live weight of animal at beginning of experiment, . . .	84.00
Live weight of animal at time of killing, . . . . .	118.25
Live weight gained during experiment, . . . . .	34.25
Dressed weight at time of killing, . . . . .	66.00
Loss in weight by dressing, . . . . .	52.25 pounds or 44.19 per cent.

## Cost of Feed consumed during Experiment.

99.90 pounds wheat bran, at \$17.00 per ton, . . . . .	\$0 85
94.74 pounds gluten meal, at \$23.00 per ton, . . . . .	1 09
281.00 pounds rowen, at \$15.00 per ton, . . . . .	2 11
178.50 pounds corn ensilage, at \$2.75 per ton, . . . . .	0 24
	<b>\$4 29</b>

13.65 pounds of dry matter yielded 1 pound of live weight.

Cost of feed for production of 1 pound of live weight, 12.52 cents.



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## 7. Detailed Statement of Feeding Record—Continued.

### Sheep No. 2.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.				Pounds of Dry Matter in Daily Fodder con- sumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced one pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Gluten Meal.	Rowen.	Corn Ensilage.					
1889-1890.									
Sept. 17 to Sept. 30, .	0.61	0.31	1.43	-	2.07	0.50	4.14	1:4.64	70.00
Oct. 1 to Dec. 3, .	0.51	0.51	1.66	-	2.36	0.22	10.73	1:4.45	82.75
Dec. 17 to Dec. 31, .	0.51	0.51	1.23	-	1.98	0.12	16.50	1:4.20	90.25
Jan. 2 to Jan. 20, .	0.50	0.50	0.58	2.92	2.19	0.29	7.55	1:5.01	95.00
Jan. 21 to Feb. 3, .	0.58	0.58	-	4.79	2.35	0.11	21.36	1:5.24	98.00

### Total Amount of Feed consumed from Sept. 5, 1889, to Feb. 3, 1890.\*

	Dry Matter (Pounds).	Cost.	Fertilizer Value.
79.61 pounds wheat bran, . . .	72.23	\$0 68	\$0 54
72.99 pounds gluten meal, . . .	65.84	0 84	0 59
188.00 pounds rowen, . . .	162.56	1 41	0 65
130.75 pounds corn fodder, . . .	35.36	0 18	0 11
	335.99	\$3 11	\$1 89

\* Includes the feed during the 12 days preceding the experiment proper.

	Pounds.
Live weight of animal at beginning of experiment, . . .	66.00
Live weight at time of killing, . . .	98.50
Live weight gained during experiment, . . .	32.50
Average gain in weight per day, . . .	0.21
Dressed weight of animal, . . .	54.00
Loss in weight by dressing, . . . 44.50 pounds, or 45.18 per cent.	
Pounds of dry matter fed to produce 1 pound of live weight, . . .	10.34
Cost of feed per pound of live weight gained, . . .	9.57 cents.
Net cost of feed per pound gained after deducting 20 per cent. of manurial value, . . .	4.92 cents.

## 7. Detailed Statement of Feeding Record—Continued.

## Sheep No. 2.

FEEDING PERIODS.	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Nutritive Ratio of Feed.	Live Weight of Animal at Beginning of Period (Pounds).	Live Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1889-1890.</b>								
Sept. 17 to Sept. 30, .	8 56	4.28	20.00	-	1:4.64	67.50	74.50	0.50
Oct. 1 to Dec. 3, .	32.63	32.63	106.00	-	1:4.45	74.50	88.50	0.22
Dec. 17 to Dec. 31, .	7.63	7.63	18.50	-	1:4.20	88.50	90.50	0.12
Jan. 2 to Jan. 20, .	9.50	9.50	11.00	55.50	1:5.01	91.50	97.00	0.29
Jan. 21 to Feb. 3, .	8.12	8.12	-	67.00	1:5.24	97.00	98.50	0.11

Total Amount of Feed consumed from Sept. 17, 1889, to Feb. 3, 1890.

	Pounds.
74.94 pounds wheat bran, equal to dry matter, . . . .	67.99
70.66 pounds gluten meal, equal to dry matter, . . . .	63.74
168.00 pounds rowen, equal to dry matter, . . . .	145.27
126.50 pounds corn ensilage, equal to dry matter, . . . .	35.36
Total amount of dry matter, . . . . .	312.36

	Pounds
Live weight of animal at beginning of experiment, . . . .	67.50
Live weight at time of killing, . . . . .	98.50
Live weight gained during experiment, . . . . .	31.00
Dressed weight at time of killing, . . . . .	54.00
Loss in weight by dressing, . . . . .	44.50 pounds, or 45.18 per cent.

## Cost of Feed consumed during Experiment.

74.94 pounds wheat bran, at \$17.00 per ton, . . . .	\$0 64
70.66 pounds gluten meal, at \$23 00 per ton, . . . .	0 81
168.00 pounds rowen, at \$15.00 per ton, . . . .	1 26
130.75 pounds corn ensilage, at \$2.75 per ton, . . . .	0 18
	<b>\$2 89</b>

10.08 pounds of dry matter yielded 1 pound of live weight.

Cost of feed for the production of 1 pound of live weight, 9.32 cents.

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### 7. Detailed Statement of Feeding Record—Continued.

#### Sheep No. 3.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.				Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Gluten Meal.	Rowen.	Corn Ensilage.					
1889-1890.									
Sept. 17 to Sept. 30, .	0.71	0.35	1.96	-	2.65	0.30	8.83	1 : 4.78	79.25
Oct. 1 to Dec. 3, .	0.64	0.64	2.37	-	3.21	0.17	18.88	1 : 4.67	88.75
Dec. 17 to Dec. 31, .	0.63	0.63	2.00	-	2.87	0.30	9.57	1 : 4.42	97.25
Jan. 2 to Jan. 20, .	0.62	0.62	1.08	3.07	2.88	0.26	11.08	1 : 4.97	100.75
Jan. 21 to Feb. 3, .	0.58	0.58	-	5.02	2.41	0.18	13.39	1 : 5.29	106.00

*Total Amount of Feed consumed from Sept. 5, 1889, to Feb. 3, 1890.\**

	Dry Matter (Pounds).	Cost.	Fertilizer Value.
95.79 pounds wheat bran, . . . .	86.91	\$0 81	\$0 65
88.49 pounds gluten meal, . . . .	79.82	1 02	0 72
274.25 pounds rowen, . . . .	237.14	2 06	0 95
149.00 pounds corn ensilage, . . . .	40.23	0 19	0 12
	444.10	\$4 08	\$2 44

\* Includes the feed during 12 days preceding the experiment proper.

	Pounds.
Live weight of animal at beginning of experiment, . . . .	71.00
Live weight at time of killing, . . . .	106.50
Live weight gained during experiment, . . . .	35.50
Average gain in weight per day, . . . .	0.23
Dressed weight of animal, . . . .	60.00
Loss in weight by dressing, . . . . 46.50 pounds, or 43.66 per cent.	
Pounds of dry matter fed to produce 1 pound of live weight, . .	12.51
Cost of feed per pound of live weight gained, . . . .	11.49 cents.
Net cost of feed per pound gained after deducting 20 per cent. of manurial value, . . . .	6.00 cents.

7. *Detailed Statement of Feeding Record—Continued.**Sheep No. 3.*

FEEDING PERIODS.	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Nutritive Ratio of Feed.	Live Weight of Animal at Beginning of Period (Pounds).	Live Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1889-1890.</b>								
Sept. 17 to Sept. 30, .	9.92	4.96	27.50	-	1:4.78	78.25	82.50	0.30
Oct. 1 to Dec. 3, .	41.06	41.06	151.50	-	1:4.67	82.50	93.50	0.17
Dec. 17 to Dec. 31, .	9.50	9.50	30.00	-	1:4.42	95.00	99.50	0.30
Jan. 2 to Jan. 20, .	11.87	11.87	20.50	58.25	1:4.97	99.00	104.00	0.26
Jan. 21 to Feb. 3, .	8.12	8.12	-	70.25	1:5.29	104.00	106.50	0.18

*Total Amount of Feed consumed from Sept. 17, 1889, to Feb. 3, 1890.*

	Pounds.
91.12 pounds wheat bran, equal to dry matter, . . . .	82.67
86.16 pounds gluten meal, equal to dry matter, . . . .	77.72
252.25 pounds rowen, equal to dry matter, . . . .	218.12
149.00 pounds corn ensilage, equal to dry matter, . . . .	40.23
Total amount of dry matter, . . . .	418.74

	Pounds.
Live weight of animal at beginning of experiment, . . . .	78.25
Live weight at time of killing, . . . .	106.50
Live weight gained during experiment, . . . .	28.25
Dressed weight at time of killing, . . . .	60.00
Loss in weight by dressing, . . . . 46.50 pounds, or 43.66 per cent.	

*Cost of Feed consumed during Experiment.*

91.12 pounds wheat bran, at \$17.00 per ton, . . . .	\$0 77
86.16 pounds gluten meal, at \$23.00 per ton, . . . .	0 99
252.25 pounds rowen, at \$15.00 per ton, . . . .	1 89
149.00 pounds corn ensilage, at \$2.75 per ton, . . . .	0 20
	<b>\$3 85</b>

14.82 pounds of dry matter yielded 1 pound of live weight.

Cost of feed for the production of 1 pound of live weight, 13.59 cents.

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## 7. Detailed Statement of Feeding Record — Continued.

### Sheep No. 4.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animals (Pounds).
	Corn Meal.	Wheat Bran.	Gluten Meal.	Rowen.	Corn Ensilage.	Corn Fodder.					
1889-1890.											
Sept. 17 to Dec. 3,	0.54	0.11	0.05	2.56	-	-	2.84	0.13	21.85	1 : 6.99	82.00
Dec. 17 to Dec. 31,	0.58	0.12	0.06	1.97	-	-	2.37	0.02	118.50	1 7 01	89.75
Jan. 2 to Jan. 20,	0.58	0.12	0.06	1.16	2.05	-	2.22	0.14	15.86	1 7.30	91.50
Feb. 4 to Feb. 15,	-	0.50	0.50	-	5.67	-	2.43	0.33	7.36	1 : 5.76	96.50
Feb. 18 to Mar. 17,	-	0.55	0.55	-	-	1.59	2.27	0.03	75.67	1 : 4.88	101.40

*Total Amount of Feed consumed from Sept. 5, 1889, to March 17, 1890.\**

	Dry Matter (Pounds).	Cost.	Fertilizer Value.
78.21 pounds corn meal, . . . .	69.09	\$0 75	\$0 25
41.99 pounds wheat bran, . . . .	38.10	0 36	0 28
32.25 pounds gluten meal, . . . .	29.09	0 37	0 26
305.50 pounds rowen, . . . .	264.16	2 70	1 06
185.75 pounds corn ensilage, . . . .	50.25	0 26	0 14
54.00 pounds corn fodder, . . . .	42.23	0 20	0 14
	492.92	\$4 64	\$2 13

\* Includes the feed during 12 days preceding the experiment proper.

	Pounds.
Live weight of animal at beginning of experiment, . . . .	67 50
Live weight at time of killing, . . . .	102.25
Live weight gained during experiment, . . . .	34.75
Average gain in weight per day, . . . .	0.18
Dressed weight of animal, . . . .	54.00
Loss in weight by dressing, . . . . 48.25 pounds, or 47.19 per cent.	
Pounds of dry matter fed to produce 1 pound of live weight, . .	14.19
Cost of feed per pound of live weight gained, . . . .	13.35 cents.
Net cost of feed per pound gained after deducting 20 per cent. of manurial value, . . . .	8.46 cents.

## 7. Detailed Statement of Feeding Record—Continued.

## Sheep No. 4.

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Total Amount of Corn Fodder consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Nutritive Ratio of Feed.	Live Weight of Animal at Beginning of Period (Pounds).	Live Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1889-1890.</b>										
Sept. 17 to Dec. 3,	41.88	4.19	8.38	-	-	200.00	1:6.99	74.50	85.00	0.13
Dec. 17 to Dec. 31,	8.65	0.87	1.73	-	-	29.50	1:7.01	90.00	90.25	0.02
Jan. 2 to Jan. 20,	10.96	1.10	2.19	39.00	-	22.00	1:7.30	90.00	92.75	0.14
Feb. 4 to Feb. 15,	-	6.00	6.00	68.00	-	-	1:5.76	96.50	100.50	0.33
Feb. 18 to Mar. 17,	-	15.50	15.50	-	44.50	-	1:4.88	101.50	102.25	0.03

Total Amount of Feed consumed from Sept. 17, 1889, to March 17, 1890.

	Pounds.
75.52 pounds corn meal, equal to dry matter, . . . .	66.71
31.98 pounds gluten meal, equal to dry matter, . . . .	28.85
41.45 pounds wheat bran, equal to dry matter, . . . .	37.61
283.50 pounds rowen, equal to dry matter, . . . .	245.14
185.75 pounds corn ensilage, equal to dry matter, . . . .	50.25
54.00 pounds corn fodder, equal to dry matter, . . . .	42.23
Total amount of dry matter, . . . .	470.79

	Pounds.
Live weight of animal at beginning of experiment, . . . .	74.50
Live weight at time of killing, . . . .	102.25
Live weight gained during experiment, . . . .	27.75
Dressed weight at time of killing, . . . .	54.00
Loss in weight by dressing, . . . . 48.25 pounds, or 47.19 per cent.	

## Cost of Feed consumed during Experiment.

75.52 pounds corn meal, at \$19.00 per ton, . . . .	\$0.72
31.98 pounds gluten meal, at \$23.00 per ton, . . . .	0.37
41.45 pounds wheat bran, at \$17.00 per ton, . . . .	0.35
283.50 pounds rowen, at \$15.00 per ton, . . . .	2.13
185.75 pounds corn ensilage, at \$2.75 per ton, . . . .	0.26
54.00 pounds corn fodder, at \$7.50 per ton, . . . .	0.20
	<b>\$4.03</b>

16.97 pounds of dry matter fed yielded 1 pound of live weight.

Cost of feed for the production of 1 pound of live weight, 14.50 cents.

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## 7. Detailed Statement of Feeding Record — Continued.

### Sheep No. 5.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Gluten Meal.	Rowen.	Corn Ensilage.	Corn Fodder.					
1889-1890.											
Sept. 17 to Dec. 3,	0.40	0.08	0.04	1.80	-	-	2.02	0.12	16.83	1: 6.99	72.75
Dec. 17 to Dec. 31,	0.39	0.08	0.04	1.47	-	-	1.72	-0.23	-	1: 7.00	75.75
Jan. 2 to Jan. 20,	0.41	0.08	0.04	0.53	2.84	-	1.70	0.36	4.72	1: 8.58	79.00
Feb. 4 to Feb. 15,	-	0.39	0.39	-	3.50	-	1.65	0.25	6.80	1: 5.37	84.25
Feb. 18 to Mar. 17,	-	0.43	0.43	-	-	0.93	1.52	-0.02	-	1: 4.53	86.75

*Total Amount of Feed consumed from Sept. 5, 1889, to March 17, 1890.\**

	Dry Matter (Pounds).	Cost.	Fertilizer Value.
59.85 pounds corn meal, . . . .	52.87	\$0 57	\$0 19
33.32 pounds wheat bran, . . . .	30.23	0 29	0 22
25.42 pounds gluten meal, . . . .	22.93	0 29	0 20
203.50 pounds rowen, . . . .	175.97	1 53	0 70
166.00 pounds corn ensilage, . . . .	44.90	0 23	0 13
31.50 pounds corn fodder, . . . .	24.74	0 12	0 08
	351.64	\$3 03	\$1 52

\* Includes the feed during 12 days preceding the experiment proper.

	Pounds.
Live weight of animal at beginning of experiment, . . . .	66.25
Live weight at time of killing, . . . .	86.50
Live weight gained during experiment, . . . .	20.25
Average gain in weight per day, . . . .	0.10
Dressed weight of animal, . . . .	46.00
Loss in weight by dressing, . . . . 40.50 pounds, or 46.82 per cent.	
Pounds of dry matter fed to produce 1 pound of live weight, . .	17.36
Cost of feed per pound of live weight gained, . . . .	14.96 cents.
Net cost of feed per pound gained after deducting 20 per cent. of manurial value, . . . .	8.94 cents.

## 7. Detailed Statement of Feeding Record—Continued.

## Sheep No. 5.

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Total Amount of Corn Fodder consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Nutritive Ratio of Feed.	Live Weight of Animal at Beginning of Period (Pounds).	Live Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1889-1890.</b>										
Sept. 17 to Dec. 3,	31.00	3.10	6.20	-	-	140.50	1:6.99	66.25	75.50	0.12
Dec. 17 to Dec. 31,	5.87	0.59	1.17	-	-	22.00	1:7.00	77.50	74.00	-0.23
Jan. 2 to Jan. 20,	7.70	0.77	1.54	54.00	-	10.00	1:8.58	75.00	81.75	0.36
Feb. 4 to Feb. 15,	-	4.63	4.63	42.00	-	-	1:5.37	83.00	86.00	0.25
Feb. 19 to Mar. 17,	-	12.13	12.13	-	26.00	-	1:4.53	87.00	86.50	-0.02

## Total Amount of Feed consumed from Sept. 17, 1889, to March 17, 1890.

	Pounds.
57.16 pounds corn meal, equal to dry matter, . . . . .	50.49
25.15 pounds gluten meal, equal to dry matter, . . . . .	22.69
32.78 pounds wheat bran, equal to dry matter, . . . . .	29.74
182.50 pounds rowen, equal to dry matter, . . . . .	157.81
166.00 pounds corn ensilage, equal to dry matter, . . . . .	40.90
31.50 pounds corn fodder, equal to dry matter, . . . . .	24.74
Total amount of dry matter, . . . . .	330.37

	Pounds.
Live weight of animal at beginning of experiment, . . . . .	66.25
Live weight at time of killing, . . . . .	86.50
Live weight gained during experiment, . . . . .	20.25
Dressed weight at time of killing, . . . . .	46.00
Loss in weight by dressing, . . . . . 40.50 pounds, or 46.82 per cent.	

## Cost of Feed consumed during Experiment.

57.16 pounds corn meal, at \$19.00 per ton, . . . . .	\$0 54
25.15 pounds gluten meal, at \$23.00 per ton, . . . . .	0 29
32.78 pounds wheat bran, at \$17.00 per ton, . . . . .	0 28
182.50 pounds rowen, at \$15.00 per ton, . . . . .	1 37
166.00 pounds corn ensilage, at \$2.75 per ton, . . . . .	0 23
31.50 pounds corn fodder, at \$7.50 per ton, . . . . .	0 12

\$2 83

16.31 pounds of dry matter fed yielded 1 pound of live weight.

Cost of feed for the production of 1 pound of live weight, 13.98 cents.



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## 7. Detailed Statement of Feeding Record—Continued.

### Sheep No. 6.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Gluten Meal.	Rowen.	Corn Ensilage.	Corn Fodder.					
<b>1889-1890.</b>											
Sept. 17 to Dec. 3,	0.48	0.10	0.05	2.21	-	-	2.47	0.17	14.53	1: 6.99	91.25
Dec. 17 to Dec. 31,	0.56	0.11	0.06	2.20	-	-	2.54	0.23	11.05	1: 7.00	99.50
Jan. 2 to Jan. 20,	0.48	0.10	0.05	0.97	1.89	-	1.91	0.16	11.94	1: 7.90	102.00
Feb. 4 to Feb. 15,	-	0.50	0.50	-	5.42	-	2.37	0.21	11.29	1: 5.68	107.50
Feb. 18 to Mar. 17,	-	0.55	0.55	-	-	1.38	2.10	-	-	1: 4.70	108.00

*Total Amount of Feed consumed from Sept. 5, 1889, to March 17, 1890.\**

	Dry Matter (Pounds).	Cost.	Fertilizer Value.
71.31 pounds corn meal, . . . .	62.99	\$0 68	\$0 23
40.61 pounds wheat bran, . . . .	36.85	0 35	0 27
31.55 pounds gluten meal, . . . .	28.45	0 36	0 25
264.50 pounds rowen, . . . .	228.71	1 98	0 92
193.50 pounds corn ensilage, . . . .	52.34	0 27	0 15
43.50 pounds corn fodder, . . . .	34.40	0 17	0 11
	443.74	\$3 81	\$1 93

\* Includes the feed during 12 days preceding the experiment proper.

	Pounds.
Live weight of animal at beginning of experiment, . . . .	79.00
Live weight at time of killing, . . . .	109.50
Live weight gained during experiment, . . . .	30.50
Average gain in weight per day, . . . .	0.16
Dressed weight of animal, . . . .	60.50
Loss in weight by dressing, . . . . 49 pounds, or 44.75 per cent.	
Pounds of dry matter fed to produce 1 pound of live weight, . .	14.55
Cost of feed per pound of live weight gained, . . . .	12.49 cents.
Net cost of feed per pound gained after deducting 20 per cent. of manurial value, . . . .	7.44 cents.

## Detailed Statement of Feeding Record—Concluded.

## Sheep No. 6.

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Corn Ensilage consumed (Pounds).	Total Amount of Corn Fodder consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Nutritive Ratio of Feed.	Live Weight of Animal at Beginning of Period (Pounds).	Live Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
1889-1890.										
to Dec. 3,	37.10	3.71	7.42	-	-	172.00	1: 6.99	83.25	96.75	0.17
to Dec. 31,	8.46	0.85	1.69	-	-	33.00	1: 7.00	98.00	101.50	0.23
to Jan. 20,	9.13	0.91	1.83	36.00	-	18.50	1: 7.90	100.50	103.50	0.16
to Feb. 15,	-	6.00	6.00	65.00	-	-	1: 5.68	105.50	108.00	0.21
to Mar. 17,	-	15.50	15.50	-	38.50	-	1: 4.70	109.50	109.50	-

## Amount of Feed consumed from Sept. 17, 1889, to March 17, 1890.

	Pounds.
pounds corn meal, equal to dry matter,	60.61
pounds gluten meal, equal to dry matter,	28.21
pounds wheat bran, equal to dry matter,	36.36
pounds rowen, equal to dry matter,	209.69
pounds corn ensilage, equal to dry matter,	52.34
pounds corn fodder, equal to dry matter,	34.40
Total amount of dry matter,	421.61

	Pounds.
Weight of animal at beginning of experiment,	83.25
Weight at time of killing,	109.50
Weight gained during experiment,	26.25
Dead weight at time of killing,	60.50
Live weight by dressing,	49 pounds, or 44.75 per cent.

## Cost of Feed consumed during Experiment.

pounds corn meal, at \$19.00 per ton,	\$0 65
pounds gluten meal, at \$23.00 per ton,	0 36
pounds wheat bran, at \$17.00 per ton,	0 34
pounds rowen, at \$15.00 per ton,	1 82
pounds corn ensilage, at \$2.75 per ton,	0 27
pounds corn fodder, at \$7.50 per ton,	0 17
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	\$3 61

pounds of dry matter fed yielded 1 pound of live weight.

Feed for the production of 1 pound of live weight, 13.75 cents.

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The composition of the fodder articles used during the experiment is the same as of those in preceding feeding records used during the corresponding months of the year.

### *Essential Fertilizing Constituents.*

Nitrogen, 17 cents per pound ; phosphoric acid, 6 cents ; potassium oxide, 4½ cents.

	Wheat Bran.	Gluten Meal.	Rowen.	Corn Ensilage.	Corn Meal.	Corn Fodder.
Moisture at 100° C., .	9.27	9.80	13.53	72.95	88.33	20.42
Nitrogen, . . . .	2.545	4.510	1.790	0.33	1.479	1.058
Phosphoric acid, .	2.900	0.392	0.351	0.138	0.713	0.510
Potassium oxide, .	1.637	0.049	0.462	0.301	0.430	0.760
Valuation per ton, .	\$13 60	\$16 18	\$6 92	\$1 56	\$6 27	\$4 89

## III. FEEDING EXPERIMENTS WITH YOUNG PIGS.

General remarks on feeding experiments with young pigs, ed in the preceding report, 1889.

Feeding experiments with pigs, 1890. Medium Yorkshire.

Feeding experiments with pigs, 1890. Medium Yorkshire  
Grade Chester White.

*Some General Remarks on raising Young Pigs  
for the Meat Market.*

Planning our experiments for raising young pigs for meat market, it was proposed at the outset (1884) to make our inquiry, for the present, in particular to the following question :—

How can we most profitably dispose of two by-products of the dairy, — skim-milk and creamery buttermilk, — as a constituent of the daily diet of young pigs raised for the meat market?

From our preceding reports in this connection, it will be seen that we consider *two conditions* on farms, namely, a *liberal supply* of either home-made skim-milk or of creamery buttermilk, or a *limited one*, when making up the fodder ration for the daily diet of the animals on trial.

The first requirement of an *economical* diet for any class of farm live stock consists in a desirable nutritive character of the feed, suitable to the kind, the condition and the purpose of the animal on trial, it became our first aim to obtain, in all cases, as far as practicable, a corresponding nutritive character of the different fodder combinations to be

used. This circumstance was secured in the following way :—  
Whenever a liberal supply of either kind of waste milk was available, the subsequently first stated course of compound-feeding the daily diet of the pigs was adopted ; while, in case of a limited supply of either kind of milk, the second mode was practiced, to provide for the increasing call for a large feed. In case of the use of grain feed, water has taken the place of milk for diffusing the latter when fed.

## I.

LIVE WEIGHT OF ANIMAL.	Corn Meal, Skim-milk.
20 to 70 pounds, . . .	2 ounces for every quart of milk consumed.
70 to 130 pounds, . . .	4 ounces for every quart of milk consumed.
130 to 200 pounds, . . .	6 ounces for every quart of milk consumed.

## II.

LIVE WEIGHT OF ANIMAL.	GRAIN MIXTURE TO SUPPLEMENT SKIM-MILK AND CORN MEAL.		
	Gluten Meal. (Weight Parts.)	Wheat Bran. (Weight Parts.)	Corn Meal. (Weight Parts.)
20 to 70 pounds, . . .	2	1	-
70 to 130 pounds, . . .	1	1	1
130 to 200 pounds, . . .	1	1	2

LIVE WEIGHT OF ANIMAL.	Nutritive Character of the Feed in Both Instances.
20 to 70 pounds, {	1 digestible nitrogenous organic constituent.
	2.8-3 non-nitrogenous organic constituents.
70 to 130 pounds, {	1 digestible nitrogenous organic constituent.
	3.6-4 non-nitrogenous organic constituents.
130 to 200 pounds, {	1 digestible nitrogenous organic constituent.
	4.5-5 non-nitrogenous organic constituents.

Our observations in this connection with the management of twelve feeding experiments, lead to the following suggestions regarding a proper course of raising pigs for the meat market:—

1. Begin as early as practicable, with a well-regulated system of feeding. During the moderate season, begin when the animals have reached from eighteen to twenty pounds in live weight; in the colder seasons, when they weigh from twenty-five to thirty pounds.

2. The feed for young pigs during their earlier stages of growth ought to be somewhat bulky, to promote the extension of their digestive organs, and to make them thereafter good eaters. A liberal supply of skim-milk or buttermilk,

a periodical increase of corn meal, beginning with two  
s of corn meal per quart of milk, has given us highly  
actory results.

Change the character of the diet, at certain stages of  
h, from a rich nitrogenous diet to that of a wider ratio  
en the digestible nitrogenous and non-nitrogenous food  
tuents of the feed. Begin, for instance, with two  
s of corn meal to one quart of skim-milk; when the  
l has reached from sixty to seventy pounds, use four  
s per quart; and feed six ounces of meal per quart  
nts live weight amounts to from one hundred and  
y to one hundred and thirty pounds. The superior  
g effect, noticed in case of one and the same diet dur-  
e earlier stages of growth, will not infrequently be  
to decrease seriously during later stages.

It is not good economy to raise pigs for the meat  
t to an exceptionally high weight. To go beyond from  
undred and seventy-five to one hundred and eighty  
s is only advisable when exceptionally high market  
for dressed pork can be secured. The quality of the  
s also apt to be impaired by an increased deposition of  
The power of assimilating food, and of converting it in  
onomical way into an increase of live weight, decreases  
he progress of age.

It pays well, as far as the cost of feed is concerned,  
tect the animals against the extremes of the season.  
ng experiments carried on during moderate seasons  
ore profitable than those carried on, under otherwise  
ponding circumstances, during the winter season.

r experiments previous to 1890 have been carried on  
mixed breeds of a more or less doubtful parentage.  
n the past year we began to compare thoroughbreds of  
et breeds with each other or with grades of known  
. The subsequent pages contain a description of two  
iments, — one with medium Yorkshires, the other with  
m Yorkshires and grade Chester Whites.

Other experiment with throughbreds — Berkshire, Tam-  
s, small Yorkshire and Poland China — is finished; the  
s will be published in connection with a second one of  
me character as soon as the latter is closed.

## Summary of Experiments I. to XII.

[Based on the same cost of feed and value of manurial refuse.]

EXPERIMENT.	Number of Pigs.	Average Weight of Pigs at Beginning of Experiment (Pounds).	Average Weight of Pigs at Close of Experiment (Pounds).	Articles of Fodder used.	Nutritive Ratio of Feed.	Pounds of Dry Matter consumed for the Production of One Pound of Dressed Pork.	Total Cost of Feed per Pound of Dressed Pork (Cents).	Manurial Value of Feed per Pound of Dressed Pork, after deducting Thirty Per Cent. (Cents).	Net Cost of Feed per Pound of Dressed Pork (Cents).
I. May 21 to Sept. 22, 1884,	{ 3 5, 6 }	48.8 47.6 30.1	239.0 263.9 209.7	Skim-milk, corn meal, Buttermilk, corn meal, Buttermilk, corn meal,	1:2.50 to 1:2.97 1:2.84 to 1:3.38 1:3.50 to 1:4.80	2.50 to 3.11; average 2.90 2.23 to 2.57; " 2.40 3.34 to 4.17; " 3.87	5.15 4.30 5.91	1.70 1.38 1.80	8.45 2.92 4.11
II. Nov. 6, 1884, to Mar. 21, 1886,	{ 6 6 }	28.7	227.0	Skim-milk, corn meal, Skim-milk, corn meal,	1:2.70 to 1:5.00 1:3.04 to 1:3.76	2.97 to 3.48; " 3.31 4.01 to 4.18; " 4.10	5.51 6.41	1.86 2.01	3.82 4.40
III. April 1 to Sept. 16, 1885,	2	49.8	276.3	Wheat bran, gluten meal, Wheat bran, gluten meal,	1:2.64 to 1:4.48 1:2.64 to 1:4.48	3.77 to 4.06; " 3.93	6.33	2.13	4.20
IV. Dec. 8, 1885, to May 31, 1886,	2	32.9	152.4	Wheat bran, gluten meal, Wheat bran, gluten meal,	1:2.75 to 1:3.57 1:2.75 to 1:3.57	3.56 to 4.31; " 3.92	5.40	2.02	3.38
V. Sept. 15, 1886, to Jan. 19, 1887,	4	32.6	175.0	Wheat bran, gluten meal, Wheat bran, gluten meal,	1:2.09 to 1:3.23 1:2.09 to 1:3.23	2.70 to 4.20; " 3.68	5.60	1.95	3.74
VI. Feb. 17 to May 2, 1887,	5	54.4	152.8	Skim-milk, corn meal, Skim-milk, corn meal,	1:2.85 to 1:4.30 1:2.85 to 1:4.30	2.83 to 3.24; " 3.07	5.15	1.76	3.39
VII. June 28 to Oct. 26, 1887,	7	24.5	193.3	Wheat bran, gluten meal, Wheat bran, gluten meal,	1:2.30 to 1:4.17 1:2.30 to 1:4.17	3.02 to 3.46; " 3.27	5.32	1.74	3.58
VIII. Nov. 8, 1887, to March 12, 1888,	6	25.2	186.4	Skim-milk, corn meal, Wheat bran, gluten meal, Corn and cob meal,	1:2.53 to 1:4.35 1:2.53 to 1:4.35	2.81 to 3.17; " 3.00	4.89	1.62	3.27
IX. April 12 to Aug. 8, 1888,	6	19.6	194.7	Wheat bran, gluten meal, Wheat bran, gluten meal,	1:2.90 to 1:4.65 1:2.90 to 1:4.65	3.40 to 3.81; " 3.60	6.07	1.75	4.32
X. April 26 to Aug. 28, 1889,	7	20.3	189.9	Wheat bran, gluten meal, Wheat bran, gluten meal,	1:2.90 to 1:4.36 1:2.90 to 1:4.36	3.80 to 3.99; " 3.89	6.11	1.98	4.18
XI. Sept. 10, 1889, to March 8, 1890,	5	20.8	189.5	Skim-milk, corn meal, Wheat bran, gluten meal,	1:2.80 to 1:4.25 1:2.80 to 1:4.25	4.07 3.98	5.90 5.72	1.99 1.96	3.91 3.76
XII. April 22 to Sept. 1, 1890,	{ 4* 4 }	33.4 30.5	182.8 190.2	Corn and cob meal, Wheat bran, gluten meal,	1:2.80 to 1:4.25 1:2.80 to 1:4.25				

\* Medium Yorkshires.

† Grade Chester Whites.

calculations included in the above summary were upon the following valuations per ton :—

	Cost.	Manurial Value.
meal, . . . . .	\$24 00	\$7 97
meal, . . . . .	30 00	6 21
milk (10 per cent. solids), . .	1.8 cts. gal.	2 25
milk (7 to 8 per cent. solids), .	1.37 " "	1 74
and cob meal, . . . . .	\$20 70	6 06
bran, . . . . .	22 50	13 51
meal, . . . . .	22 50	17 49

## 2. *Eleventh Feeding Experiment with Pigs.*

ed, medium Yorkshire; feed, skim-milk, corn meal, wheat and gluten meal; time, Sept. 10, 1889, to March 3, 1890.

re pigs, sows, weighing at the beginning of the experiment from 18.5 to 21 pounds each, served for our observation.

The systematic feeding began Sept. 10, 1889, and ended March 3, 1890, lasting thus 175 days. The live weight gained during that time varied in case of different pigs from 160.75 to 178 pounds, with a daily average gain of .97 pound.

The daily consumption of skim-milk during the entire experiment was limited to 5 quarts per head, with the exception of the first ten days, when but 4 quarts were called for. Two ounces of corn meal were added to every quart of skim-milk consumed, to complete the daily ration for that period. The additional supply of food needed in consequence of the growth of the animal was composed of a mixture of,—

- I. { Wheat bran, one weight part.
- { Gluten meal, two weight parts.

beginning with a daily ration of the mixture of 6 ounces per head, and increasing the quantity gradually until it



reached to from 30 to 36 ounces. This point was obtained at the close of the second month of the observation, November 11. The live weights of the different animals varied at that time from 85 to 95 pounds. The nutritive ratio, *i. e.*, the relative proportion of the digestible nitrogen-containing organic constituents and non-nitrogen-containing organic constituents, calling the former one, in the daily fodder ration, remained practically the same during the first two months (1 : 3).

The composition of the grain feed was changed at the stated advance in the growth of the animal, while the daily quantity of skim-milk per head remained the same as before,—5 quarts. The above specified grain mixture (I.) was simply replaced by the following,—

- II. { Corn meal, four weight parts.  
Wheat bran, one weight part.  
Gluten meal, one weight part.

beginning with a daily average ration of 32 to 36 ounces per head, and closing with one of 42 to 45 ounces, December 30, when their respective live weights varied from 125 to 130 pounds.

The subsequent change in the composition of the daily diet consisted in an increase of the proportion of the corn meal in the daily grain feed. The daily quantity of skim-milk, 5 quarts, remained the same to the end of the experiment. An amount of water was added sufficient to satisfy the thirst of the animal. The new grain mixture (III.) consisted of,—

- III. { Corn meal, six weight parts.  
Wheat bran, one weight part.  
Gluten meal, one weight part.

The amount consumed per day rose to 48 ounces per head in some instances, toward the close of the experiment.

The entire management of the feeding was divided, as will be noticed, into three periods, as far as the nutritive character of the daily diet was concerned :—

No.	Live Weight.	Nutritive Ratio.
.	20 to 90 pounds, .	{ 1 digestible nitrogenous organic constituent. 3 non-nitrogenous organic constituents.
.	90 to 130 pounds, .	{ 1 digestible nitrogenous organic constituent. 3.8 non-nitrogenous organic constituents.
.	130 to 200 pounds,	{ 1 digestible nitrogenous organic constituent 4.25 non-nitrogenous organic constituents.

*Conclusions deduced from the Results obtained.*

The amount of dry organic matter contained in the consumed per pound of dressed pork secured varies in of different animals from 3.80 to 3.99 pounds, the being 3.87 pounds.

The total cost of the feed consumed for the production one pound of dressed pork secured varies in case of different animals from 5.43 to 5.72 cents, with a mean of 5.57 cents.

The total cost of the entire feed consumed during our experiment XI. amounts to \$39. The total market value of the entire amount of the essential fertilizing constituents contained in the feed consumed amounts at current market prices to \$19.92. In making the customary liberal allowance of 30 per cent. for the loss sustained in nitrogen, phosphoric acid and potassium oxide, in consequence of the utilization of flesh and bone in the growing animals, it will be noticed that the obtainable manurial value of the feed consumed amounts still to \$13.94, which sum is fairly equal to one-third of the original cost of the entire feed used, or 4.78 cents per pound of dressed pork produced (702.75 lbs).

As the first cost of the feed consumed for the production of one pound of dressed pork amounted on an

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average to 5.55 cents, and as the available manurial value of the feed for the same weight of dressed pork produced was equal to 1.98 cents, it will be seen that the average net value of the feed consumed amounted to 3.57 cents per pound of dressed pork produced.

5. Comparing the financial results of the experiment under discussion with those of an earlier experiment of the same kind (IV.), adopting for that purpose in both the same market price for the fodder articles consumed, and allowing in the same time a corresponding selling price for the dressed pork produced, no material difference can be pointed out. During our earlier experiment, corn meal sold at \$22.50, wheat bran \$22.50; during our previously described experiment corn meal sold at \$19 and wheat bran at \$16.50 per ton; skim-milk and gluten meal were charged alike in both experiments. In the earlier experiment the *net cost of feed consumed* for the production of one pound of dressed pork was 4.20 cents, and in our recent experiment, as above stated, 3.57 cents. The difference of .63 cent is in favor of the recent trial is essentially due to contemporary lower market prices of corn meal and wheat bran.

For further details, see statements upon a few subsequent pages.

### *Feeding Record of Pigs.*

(1)

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).
<b>1889-1890.</b>							
Sept. 10 to Sept. 30, .	11.63	93.00	-	-	1:3.05	20.75	38.00
Oct. 1 to Nov. 11, .	26.25	210.00	20.71	41.42	1:2.99	38.00	90.50
Nov. 12 to Dec. 30, .	73.52	245.00	18.38	18.38	1:3.81	90.50	133.50
Dec. 31 to Mar. 3, .	120.12	334.00	20.02	20.02	1:4.06	133.50	187.75

*Amount of Feed consumed from Sept. 10, 1889, to March 3, 1890.*

	Pounds.
pounds corn meal, equal to dry matter, . . . .	204.50
quarts skim-milk, equal to dry matter, . . . .	195.60
pounds wheat bran, equal to dry matter, . . . .	53.63
pounds gluten meal, equal to dry matter, . . . .	72.00

total amount of dry matter, . . . . . 525.73

	Pounds.
weight of animal at beginning of experiment, . . . .	20.75
weight at time of killing, . . . . .	187.75
weight gained during experiment, . . . . .	167.00
weight at time of killing, . . . . .	155.50
weight by dressing, . . . . . 32.25 pounds, or 17.18 per cent.	
weight gained during experiment, . . . . .	138.50

*Cost of Feed consumed during Experiment.*

pounds corn meal, at \$19.00 per ton, . . . .	\$2 20
gallons skim-milk, at 1.8 cents per gallon, . . . .	3 97
pounds wheat bran, at \$16.50 per ton, . . . .	0 49
pounds gluten meal, at \$23.00 per ton, . . . .	0 92
	<hr/>
	\$7 58

pounds of dry matter fed yielded 1 pound of live weight, and  
pounds of dry matter yielded 1 pound of dressed weight.

al cost of feed for the production of 1 pound of dressed pork,  
ents.

cost of feed for the production of 1 pound of dressed pork, 3.49

(2)

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1889-1890.</b>								
Oct. 10 to Sept. 30, . . . .	11.63	93.00	-	-	1:3.05	19.00	37.00	0.66
Oct. 1 to Nov. 11, . . . .	26.25	210.00	22.46	44.92	1:2.99	37.00	93.75	1.35
Nov. 12 to Dec. 30, . . . .	68.48	245.00	17.12	17.12	1:3.74	93.75	127.00	0.68
Dec. 31 to Mar. 3, . . . .	156.36	334.00	26.06	26.06	1:4.86	127.00	197.25	1.12

# 100 AGRICULTURAL EXPERIMENT STATION. [Jan.

*Total Amount of Feed consumed from Sept. 10, 1889, to March 3, 1890.*

	Pounds.
262.72 pounds corn meal, equal to dry matter, . . . .	232.06
882.00 quarts skim-milk, equal to dry matter, . . . .	195.60
65.64 pounds wheat bran, equal to dry matter, . . . .	59.56
88.10 pounds gluten meal, equal to dry matter, . . . .	79.47

Total amount of dry matter, . . . . . 566.69

	Pounds.
Live weight of animal at beginning of experiment, . . . .	19.00
Live weight at time of killing, . . . . .	197.25
Live weight gained during experiment, . . . . .	178.25
Dressed weight at time of killing, . . . . .	163.50
Loss in weight by dressing, . . . . . 33.75 pounds, or 17.11 per cent.	
Dressed weight gained during experiment, . . . . .	147.75

## *Cost of Feed consumed during Experiment.*

262.72 pounds corn meal, at \$19.00 per ton, . . . .	\$2 50
220.50 gallons skim-milk, at 1.8 cents per gallon, . . . .	3 97
65.64 pounds wheat bran, at \$16.50 per ton, . . . .	0 54
88.10 pounds gluten meal, at \$23.00 per ton, . . . .	1 01
	<hr/>
	\$8 02

3.18 pounds of dry matter fed yielded 1 pound of live weight, and 3.84 pounds of dry matter yielded 1 pound of dressed weight.

Total cost of feed for the production of 1 pound of dressed pork, 5.43 cents.

Net cost of feed for the production of 1 pound of dressed pork, 3.45 cents.

(3)

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-Milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1889-1890.</b>								
Sept. 10 to Sept. 30, . . . .	11.63	93.00	-	-	1:3.05	24.25	41.75	0.83
Oct. 1 to Nov. 11, . . . .	26.25	210.00	22.08	44.16	1:2.99	41.75	92.75	1.21
Nov. 12 to Dec. 23, . . . .	83.48	210.00	20.87	20.87	1:4.08	92.75	136.50	1.04
Dec. 24 to Mar. 3, . . . .	153.30	369.00	25.55	25.55	1:4.23	136.50	199.00	0.89

*Amount of Feed consumed from Sept. 10, 1889, to March 3, 1890.*

	Pounds.
66 pounds corn meal, equal to dry matter, . . . .	242.61
00 quarts skim-milk, equal to dry matter, . . . .	195.60
50 pounds wheat bran, equal to dry matter, . . . .	62.15
58 pounds gluten meal, equal to dry matter, . . . .	81.70
Total amount of dry matter, . . . . .	582.06

	Pounds.
weight of animal at beginning of experiment, . . . .	24.25
weight at time of killing, . . . . .	199.00
weight gained during experiment, . . . . .	174.75
weight at time of killing, . . . . .	167.00
weight lost by dressing, . . . . . 32.00 pounds, or 16.08 per cent.	
weight gained during experiment, . . . . .	146.75

*Cost of Feed consumed during Experiment.*

66 pounds corn meal, at \$19.00 per ton, . . . .	\$2 61
50 gallons skim-milk, at 1.8 cents per gallon, . . . .	3 67
50 pounds wheat bran, at \$16.50 per ton, . . . .	0 57
58 pounds gluten meal, at \$23.00 per ton, . . . .	1 04
	<hr/>
	\$8 19

33 pounds of dry matter fed yielded 1 pound of live weight, and  
pounds of dry matter yielded 1 pound of dressed weight.

total cost of feed for the production of 1 pound of dressed pork,  
cents.

et cost of feed for the production of 1 pound of dressed pork, 3.60  
cents.

(4)

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1889-1890.</b>								
10 to Sept. 30, . .	11.63	93.00	-	-	1:3.05	21.25	38.00	0.80
1 to Nov. 11, . .	26.25	210.00	22.46	44.92	1:2.99	38.00	90.25	1.24
12 to Dec. 23, . .	79.12	210.00	19.78	19.78	1:4.03	90.25	132.00	0.99
24 to Mar. 3, . .	118.68	369.00	19.78	19.78	1:3.94	132.00	184.00	0.74

# 102 AGRICULTURAL EXPERIMENT STATION. [Jan.

*Total Amount of Feed consumed from Sept. 10, 1889, to March 3, 1890.*

	Pounds.
235.68 pounds corn meal, equal to dry matter, . . . .	208.18
882.00 quarts skim-milk, equal to dry matter, . . . .	195.60
62.02 pounds wheat bran, equal to dry matter, . . . .	56.09
84.48 pounds gluten meal, equal to dry matter, . . . .	76.20

Total amount of dry matter, . . . . . 536.07

	Pounds.
Live weight of animal at beginning of experiment, . . . .	21.25
Live weight at time of killing, . . . . .	184.00
Live weight gained during experiment, . . . . .	162.75
Dressed weight at time of killing, . . . . .	152.00
Loss in weight by dressing, . . . . 32.00 pounds, or 17.39 per cent.	
Dressed weight gained during experiment, . . . . .	134.50

## *Cost of Feed consumed during Experiment.*

235.68 pounds corn meal, at \$19.00 per ton, . . . .	\$2 24
220.50 gallons skim-milk, at 1.8 cents per gallon, . . . .	3 97
62.02 pounds wheat bran, at \$16.50 per ton, . . . .	0 51
84.48 pounds gluten meal, at \$23.00 per ton, . . . .	0 97
	<b>\$7 69</b>

3.29 pounds of dry matter fed yielded 1 pound of live weight, and 3.99 pounds of dry matter yielded 1 pound of dressed weight.

Total cost of feed for the production of 1 pound of dressed pork, 5.72 cents.

Net cost of feed for the production of 1 pound of dressed pork, 3.74 cents.

(5)

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1889-1890.</b>								
Sept. 10 to Sept. 30, . . . .	11.63	93.00	-	-	1:3.05	18.75	35.75	0.81
Oct. 1 to Nov. 11, . . . .	26.25	210.00	20.03	40.16	1:2.98	35.75	83.50	1.14
Nov. 12 to Jan. 6, . . . .	68.25	280.00	17.06	17.06	1:3.61	83.50	128.00	0.80
Jan. 7 to Mar. 3, . . . .	124.14	290.00	20.89	20.69	1:4.23	128.00	179.50	0.92

*Amount of Feed consumed from Sept. 10, 1889, to March 3, 1890.*

	Pounds.
27 pounds corn meal, equal to dry matter, . . . .	203.40
100 quarts skim-milk, equal to dry matter, . . . .	195.60
83 pounds wheat bran, equal to dry matter, . . . .	52.47
91 pounds gluten meal, equal to dry matter, . . . .	70.27

Total amount of dry matter, . . . . . 521.74

	Pounds.
Weight of animal at beginning of experiment, . . . .	18.75
Weight at time of killing, . . . . .	179.50
Weight gained during experiment, . . . . .	160.75
Dressed weight at time of killing, . . . . .	151.00
Loss in weight by dressing, . . . . . 28.50 pounds, or 15.87 per cent.	
Dressed weight gained during experiment, . . . . .	135.25

*Cost of Feed consumed during Experiment.*

27 pounds corn meal, at \$19.00 per ton, . . . .	\$2 19
50 gallons skim-milk, at 1.8 cents per gallon, . . . .	3 97
83 pounds wheat bran, at \$16.50 per ton, . . . .	0 48
91 pounds gluten meal, at \$23.00 per ton, . . . .	0 90
	<hr/>
	\$7 54

25 pounds of dry matter fed yielded 1 pound of live weight, and  
 6 pounds of dry matter yielded 1 pound of dressed weight.

Total cost of feed for the production of 1 pound of dressed pork, 5.57

cents.

Net cost of feed for the production of 1 pound of dressed pork, 3.59

cents.

*Summary of Experiment XI.*

	Corn Meal (Pounds).	Skim-milk (Gallons).	Wheat Bran (Pounds).	Gluten Meal (Pounds).	Live Weight gained during Experiment (Pounds).	Dressed Weight gained during Experiment (Pounds).	Cost per Pound of Dressed Pork (Cents).
No. 1, .	231.52	220.5	59.11	79.82	167.00	138.50	5.47
No. 2, .	262.72	220.5	65.64	88.10	178.25	147.75	5.43
No. 3, .	274.66	220.5	68.60	90.58	174.75	146.75	5.58
No. 4, .	235.68	220.5	62.02	84.48	162.75	134.50	5.72
No. 5, .	230.27	220.5	57.83	77.91	160.75	152.5	5.57
Total, .	1,234.85	1,102.5	313.10	420.89	843.50	702.75	-



# 104 AGRICULTURAL EXPERIMENT STATION. [Jan.

## *Total Cost of Feed consumed during Experiment.*

1,102.50 gallons skim-milk, at 1.8 cents per gallon, . . .	\$19 85
1,234.85 pounds corn meal, at \$19.00 per ton, . . .	11 73
313.10 pounds wheat bran, at \$16.50 per ton, . . .	2 58
420.89 pounds gluten meal, at \$23.00 per ton, . . .	4 84
	<hr/>
	\$39 00

Average cost of feed for production of 1 pound of dressed pork, 5.55 cents.

Average net cost of feed for production of 1 pound of dressed pork, after deducting the manurial value less 30 per cent., 3.57 cents.

## *Valuation of Essential Fertilizing Constituents in the Various Articles of Fodder used.*

Nitrogen, 17 cents per pound; phosphoric acid, 6 cents; potassium oxide, 4½ cents.

	Corn Meal.	Skim-milk	Wheat Bran.	Gluten Meal
Moisture at 100° C., . . .	11.67	89.78	9.27	9.80
Nitrogen, . . . . .	1.479	0.52	2.545	4.510
Phosphoric acid, . . . .	0.713	0.19	2.900	0.392
Potassium oxide, . . . .	0.430	0.20	1.637	0.049
Valuation per 2,000 pounds, .	\$6 27	\$2 18	\$14 59	\$15 85

## *Manurial Value of Feed consumed during Experiment.*

Corn Meal.	Skim-milk.	Wheat Bran.	Gluten Meal.	Total.
\$3 87	\$10 43	\$2 28	\$3 34	\$19 92

The manurial value of feed for the production of 1 pound of dressed pork is 2.83 cents; after the deduction of 30 per cent., 1.98 cents.

*Composition of Fodder Articles fed during the Previously  
Described Experiment*

*Skim-milk (Average).*

[One quart = 2.17 pounds.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Temperature at 100° C., . . .	89.78	1,795.60	-	-	1:2.13
Matter, . . . . .	10.22	204.40	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Ash, . . . . .	6.85	137.00	-	-	
Cellulose, . . . . .	-	-	-	-	
Fat, . . . . .	3.82	76.40	76.40	100	
Protein (nitrogenous matter), . . . . .	31.60	632.00	632.00	100	
Nitrogenous extract matter, . . . . .	57.73	1,155.60	1,155.60	100	
	100.00	2,000.00	1,864.00	-	

*Gluten Meal.*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Temperature at 100° C., . . .	9.80	196.00	-	-	1:2.60
Matter, . . . . .	90.20	1,804.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Ash, . . . . .	1.25	25.00	-	-	
Cellulose, . . . . .	1.75	35.00	11.90	34	
Fat, . . . . .	7.00	140.00	106.40	76	
Protein (nitrogenous matter), . . . . .	31.25	625.00	531.25	85	
Nitrogenous extract matter, . . . . .	58.75	1,175.00	1,104.50	94	
	100.00	2,000.00	1,754.05	-	

For analyses of corn meal and wheat bran used in this  
experiment, see winter cow feeding experiment.

### 3. *Twelfth Feeding Experiment with Pigs.*

Breed, medium Yorkshire, grade Chester White; feed, skim-milk, corn and cob meal, wheat bran, gluten meal; time, April 22 to Sept. 1, 1890.

Eight pigs, four medium Yorkshires and four grade Chester Whites, were secured for the trial. Each lot consisted of two sows and two barrows. The individual live weight of the medium Yorkshires varied from 30 to 37 pounds, and that of the grade Chester Whites from 28.75 to 33 pounds, at the beginning of the observation. The feeding began April 22 and closed September 1, thus covering a period of 133 days.

The general course pursued in the management of the experiment is materially the same as adopted in the preceding VII., VIII., IX., X., XI. The main alteration consists in the substitution of corn and cob meal in place of the corn meal. The amount of skim-milk consumed daily per head remained practically the same, after the first week, — four quarts. To every quart of milk required were added two ounces of corn and cob meal. The additional feed subsequently needed consisted of a mixture of two weight parts of gluten meal and one of wheat bran. At the close of the second month of our trial, when the live weights of the various animals amounted to from 120 to 130 pounds each, the diet was changed; a mixture of four weight parts of corn and cob meal and one weight part each of gluten meal and wheat bran was fed with the original quantity of skim-milk, — four quarts daily per head. The subsequent tabular statement shows the changes in the nutritive character of the feed at different stages of growth. The entire experiment might be divided practically into three feeding periods: —

	Live Weight.	Nutritive Ratio.
Period I., . . . . .	20 to 90 pounds.	1:2.83
Period II., . . . . .	90 to 130 pounds.	1:3.60
Period III., . . . . .	130 to 200 pounds.	1:4.25

The live weight gained during the experiment amounted in the case of the four medium Yorkshires to 596 pounds, and in the case of the four grade Chester Whites to 640 pounds, showing an increase of 44 pounds in favor of the latter.

*Medium Yorkshires.*

	Pounds.	Pounds.
1. Sow, live weight at beginning, .	37.00	Live weight at close, 174.5
2. Barrow, live weight at beginning, .	32.25	Live weight at close, 197.6
3. Sow, live weight at beginning, .	30.00	Live weight at close, 163.0
4. Barrow, live weight at beginning, .	34.25	Live weight at close, 195.0
	<hr/> 133.50	<hr/> 729.5

*Grade Chester Whites.*

	Pounds.	Pounds.
1. Sow, live weight at beginning, .	31.25	Live weight at close, 207.0
2. Sow, live weight at beginning, .	33.00	Live weight at close, 177.5
3. Barrow, live weight at beginning, .	29.00	Live weight at close, 199.0
4. Barrow, live weight at beginning, .	28.75	Live weight at close, 178.5
	<hr/> 122.00	<hr/> 762.0

The live weight gained during the experiment varied, as will be noticed from the preceding detailed record in case of different animals of medium Yorkshires from 133 to 164.75 pounds, and in case of grade Chester Whites from 144.5 to 175.75 pounds. Considering in both cases the entire lot, the average gain in live weight per head is 149 pounds in case of the medium Yorkshires, and 160 pounds in that of grade Chester Whites. This difference in the live weights of both lots disappears in the weights of the dressed pork.

*Medium Yorkshires.*

	Pounds.
1. Dressed weight, . . . . .	134
2. Dressed weight, . . . . .	158
3. Dressed weight, . . . . .	130
4. Dressed weight, . . . . .	157
Total, . . . . .	<hr/> 579

*Grade Chester Whites.*

	Pounds.
1. Dressed weight, . . . . .	160
2. Dressed weight, . . . . .	128
3. Dressed weight, . . . . .	151
4. Dressed weight, . . . . .	138
Total, . . . . .	<hr/> 577

The shrinkage of the medium Yorkshires was equal to 21 per cent., and that of the grade Chester Whites 24 per cent., of their live weights. The large percentage of shrinkage is mainly due to the fact that by some oversight the animals had been fed once on the day of killing. The medium Yorkshires lead the grade Chester Whites by two pounds in dressed weight, making the result an exceptionally close one.

Four and seven-hundredths pounds of dry matter in the feed produced one pound of dressed pork in the case of the medium Yorkshires, while 3.98 pounds of dry matter in the feed produced one pound of dressed pork in case of grade Chester Whites.

The market cost of feed consumed for the production of one pound of dressed pork was 5.60 cents in the case of medium Yorkshires, and 5.45 cents in that of the grade Chester Whites. The market cost of the feed consumed is \$26.51 in the case of the medium Yorkshires, and in that of the grade Chester Whites it is \$26.41.

The manurial value of the nitrogen, phosphoric acid and potassium oxide contained in the feed consumed is in the first-named instance equal to \$13.46, and in the latter \$13.59. Allowing 30 per cent. of the stated essential fertilizing constituents as retained in the organization of the growing animal and thus lost, there remain 70 per cent. of them obtainable in the manure. The obtainable portion of the manurial constituents of the feed is worth \$9.42 in the case of the medium Yorkshires, and \$9.51 in that of the grade Chester Whites, making the net cost of feed in the first-named lot \$17.09, and in the second lot \$16.90.

The net cost of the feed consumed for the production of one pound of dressed pork is 3.61 cents in the case of the medium Yorkshires, and 3.49 cents in that of the grade Chester Whites,—a difference of .12 cent per pound in favor of the latter.

*Medium Yorkshires (Four Pigs).*

FEEDING PERIODS.	Total Amount of Corn and Cob Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day during Period (Pounds).
<b>1890.</b>								
April 22 to June 2, .	88.69	713.50	35.94	71.88	1: 2.83	133.50	286.00	3.54
June 3 to July 21, .	351.56	882.00	131.06	131.06	1: 3.68	286.00	515.75	4.69
July 22 to Sept. 8, .	532.51	876.00	114.40	114.40	1: 4.25	515.75	729.50	4.86

*Total Amount of Feed consumed from April 22 to Sept. 8, 1890.*

	Pounds.
972.76 pounds corn and cob meal, equal to dry matter, .	836.28
471.50 quarts skim-milk, equal to dry matter, . . .	548.11
281.40 pounds wheat bran, equal to dry matter, . . .	248.98
317.34 pounds gluten meal, equal to dry matter, . . .	290.43
Total amount of dry matter, . . . . .	1,923.80

	Pounds.
Aggregate live weight of animals at beginning of experiment,	133.50
Aggregate live weight at time of killing, . . . . .	729.50
Live weight gained during experiment, . . . . .	596.00
Dressed weight at time of killing, . . . . .	579.00
Loss in weight by dressing, . . . . . 20.63 per cent., or	150.50
Dressed weight gained during experiment, . . . . .	473.04

*Cost of Feed consumed during Experiment.*

972.76 pounds corn and cob meal, at \$18.00 per ton, . . .	\$8 75
471.88 gallons skim-milk, at 1.8 cents per gallon, . . .	11 12
281.40 pounds wheat bran, at \$19.00 per ton, . . . . .	2 67
317.34 pounds gluten meal, at \$25.00 per ton, . . . . .	3 97
	<hr/>
	\$26 51

3.23 pounds of dry matter fed yielded 1 pound of live weight, and .07 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for the production of 1 pound of dressed pork at stated market prices, 5.60 cents.

Net cost per pound of dressed pork produced, 3.61 cents.

# 110 AGRICULTURAL EXPERIMENT STATION. [Jan.

## *Grade Chester Whites (Four Pigs).*

FEEDING PERIODS.	Total Amount of Corn and Cob Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day during Period (Pounds).
<b>1890.</b>								
April 22 to June 2, .	90.25	728.00	46.21	92.42	1: 2.81	122.00	312.00	4.52
June 3 to July 21, .	353.94	882.00	133.44	133.44	1: 3.68	312.00	541.00	4.67
July 22 to Sept. 1, .	504.47	750.00	123.99	123.99	1: 4.26	541.00	762.00	5.26

### *Total Amount of Feed consumed from April 22 to Sept. 1, 1890.*

	Pounds.
948.66 pounds corn and cob meal, equal to dry matter, .	815.56
2,360.00 quarts skim-milk, equal to dry matter, . . .	523.39
303.63 pounds wheat bran, equal to dry matter, . . .	268.65
349.85 pounds gluten meal, equal to dry matter, . . .	320.18
<b>Total amount of dry matter, . . . . .</b>	<b>1,927.78</b>

	Pounds.
Aggregate live weight of animals at beginning of experiment,	122.00
Aggregate live weight at time of killing, . . . . .	762.00
Live weight gained during experiment, . . . . .	640.00
Dressed weight at time of killing, . . . . .	577.00
Loss in weight by dressing, . . . . . 24.28 per cent, or	185.00
Dressed weight gained during experiment, . . . . .	484.62

### *Cost of Feed consumed during Experiment.*

948.66 pounds corn and cob meal, at \$18.00 per ton, . . .	\$8 54
590.00 gallons skim-milk, at 1.8 cents per gallon, . . .	10 62
303.63 pounds wheat bran, at \$19.00 per ton, . . . . .	2 88
349.85 pounds gluten meal, at \$25.00 per ton, . . . . .	4 37
	<b>\$26 41</b>

3.01 pounds of dry matter fed yielded 1 pound of live weight, and 3.98 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for the production of 1 pound of dressed pork at stated market prices, 5.45 cents.

Net cost per pound of dressed pork produced, 3.49 cents.

*Composition of Essential Fertilizing Constituents in the Various Fodder Articles used.*

nitrogen, 17 cents per pound; phosphoric acid, 6 cents; potassium oxide, 4½ cents.

	Corn and Cob Meal.	Skim-milk	Wheat Bran.	Gluten Meal.
Temperature at 100° C., . . . .	14.03	89.78	11.52	8.48
Nitrogen, . . . . .	1.279	0.520	2.600	5.358
Phosphoric acid, . . . . .	0.576	0.190	2.870	0.425
Potassium oxide, . . . . .	0.440	0.200	1.620	0.045
Composition per 2,000 pounds, . .	\$5 43	\$2 18	\$13 74	\$19 13

*Manurial Value of the Feed.*

	Grade Chester Whites.	Medium Yorkshires.
Corn and cob meal, . . . . .	\$2 58	\$2 65
Skim-milk, . . . . .	5 58	5 85
Wheat bran, . . . . .	2 09	1 93
Gluten meal, . . . . .	3 34	3 03
	\$13 59	\$13 46

*Composition of Fodder Articles fed during the Previously Described Experiment.*

*Corn and Cob Meal.*

	Per Cent.
Temperature at 100° C., . . . . .	14.03
Nitrogen matter, . . . . .	85.97
	100.00

*Analysis of Dry Matter.*

Ash, . . . . .	1.74
Cellulose, . . . . .	3.96
Fat, . . . . .	3.59
Protein (nitrogenous matter), . . . . .	9.30
Nitrogenous extract matter, . . . . .	81.41
	100.00



*Corn Meal (Average).*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	12.39	247.80	-	-	1:9.70
Dry matter, . . .	87.61	1,752.20	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . .	1.80	36.00	-	-	
“ cellulose, . . .	1.80	36.00	12.24	34	
“ fat, . . .	5.01	100.20	76.15	76	
“ protein (nitrogenous matter), . . .	10.46	209.20	177.82	85	
Non-nitrogenous extract matter, . . .	80.93	1,618.60	1,521.48	94	
	100.00	2,000.00	1,787.69	-	

Skin-milk, same as in pig feeding experiment XI.

Wheat bran, same as in summer cow feeding experiment.

## IV. FODDER ANALYSES. (1890.)

The majority of the analyses stated under the above are made of fodder articles which have been used during the past year in connection with some of our experiments, or have been raised upon the grounds of the station. Some articles sent on by outside parties are added, on account of the special interest they may present to others.

In presenting these analyses, it seems but proper to call the attention of farmers once more forcibly to a careful consideration of the following facts.

The composition of the various articles of food used in practice exerts a decided influence on the manurial value of the animal excretions, resulting from their use in the diet of different kinds of farm live stock. The more ash, phosphoric acid, and, in particular, nitrogen, a fodder contains, the more valuable will be, under otherwise corresponding circumstances, the manurial residue left behind after it has served its purpose as a constituent of the food consumed.

As the financial success in a mixed farm management depends, in a considerable degree, on the amount, the character and the cost of the manurial refuse material produced in connection with the special farm industry carried on, it needs no further argument to prove that the relations which exist between the composition of the fodder and the value of the manure resulting deserve the careful consideration of the farmer, when devising an efficient and at the same time an economical diet for his live stock.

The higher or lower commercial value of the manurial residue left behind after the feed has accomplished its purpose, in a satisfactory degree, decides its actual or net cost to the farm industry. A disregard of this circumstance renders, in many instances, a remunerative dairying not less doubtful than a profitable feeding of live stock for the meat market.

*Corn Meal.*

[Amherst Mill.]

84.98 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.	
Moisture at 100° C., . . .	13 00	260.00	-	-	} 1 : 9.94	
Dry matter, . . . . .	87.00	1,740.00	-	-		
	100.00	2,000.00	-	-		
<i>Analysis of Dry Matter.</i>						
Crude ash, . . . . .	1 10	22.00	-	-		
“ cellulose, . . . . .	2.09	41 80	14.21	34		
“ fat, . . . . .	4.95	99.00	75.24	76		
“ protein (nitrogenous matter), . . . . .	10 27	205 40	174.59	85		
Non-nitrogenous extract matter, . . . . .	81.59	1,631.80	1,533 89	94		
	100 00	2,000.00	1,797.93	-		

*Corn and Cob Meal.*

[Amherst Mill.]

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	8.10	14.03
Dry matter, . . . . .	91.90	85.97
	100.00	100.00
<i>Analysis of Dry Matter.</i>		
Crude ash, . . . . .	1.47	1.74
“ cellulose, . . . . .	5.63	3.96
“ fat, . . . . .	3.73	3.59
“ protein (nitrogenous matter), . . . . .	9.79	9.30
Non-nitrogenous extract matter, . . . . .	79.38	81.41
	100.00	100.00
Passed screen 144 meshes to square inch, . . . . .	76.34	72.48

*Corn Meal.*

[Amherst Mill.]

87.90 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	13.64	272.80	-	-	1:9.95
Water matter, . . . . .	86.36	1,727.20	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Ash, . . . . .	2.52	50.40	-	-	
Cellulose, . . . . .	1.78	35.60	12.10	34	
Fat, . . . . .	4.83	96.60	73.42	76	
Protein (nitrogenous matter), . . . . .	10.13	202.60	172.21	85	
Nitrogenous extract matter, . . . . .	80.74	1,614.80	1,517.91	94	
	100.00	2,000.00	1,775.64	-	

*Corn Meal.*

[Amherst Mill.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	12.39	247.80	-	-	1:9.80
Water matter, . . . . .	87.61	1,752.20	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Ash, . . . . .	1.80	36.00	-	-	
Cellulose, . . . . .	1.80	36.00	12.24	34	
Fat, . . . . .	5.01	100.20	76.15	76	
Protein (nitrogenous matter), . . . . .	10.46	209.20	177.82	85	
Nitrogenous extract matter, . . . . .	80.93	1,618.60	1,521.48	94	
	100.00	2,000.00	1,787.69	-	

*Corn Meal.*

[Sent on from Bolton, Mass.]

	PER CENT.		
	Cob Meal.	Corn Meal.	Corn Meal.
Moisture at 100° C., . . . . .	16.09	16.00	16.13
Dry matter, . . . . .	83.91	84.00	83.87
	100.00	100.00	100.00
<i>Analysis of Dry Matter.</i>			
Crude ash, . . . . .	2.50	1.82	1.99
“ cellulose, . . . . .	5.71	1.24	1.55
“ fat, . . . . .	4.48	4.21	5.00
“ protein (nitrogenous matter), . . . . .	9.69	11.01	10.43
Non-nitrogenous extract matter, . . . . .	77.62	81.72	81.03
	*100.00	100.00	100.00
Passed screen 144 meshes to square inch, . . . . .	60.50	89.91	82.64

*Corn Meal.*

[Two samples, sent on by Geo. C. Fitch, East Amherst, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	13.92	14.53
Dry matter, . . . . .	86.08	85.47
	100.00	100.00
<i>Analysis of Dry Matter.</i>		
Crude ash, . . . . .	1.59	1.66
“ cellulose, . . . . .	1.93	1.44
“ fat, . . . . .	4.95	4.84
“ protein (nitrogenous matter), . . . . .	9.73	10.16
Non-nitrogenous extract matter, . . . . .	81.80	81.90
	100.00	100.00
Passed screen 144 meshes to square inch, . . . . .	90.48	73.50

*Wheat Bran.*

[Amherst Mill.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
ture at 100° C., . . .	9.69	193.80	—	—	} 1:3.68
matter, . . . . .	90.31	1,806.20	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
le ash, . . . . .	7.40	148.00	—	—	
cellulose, . . . . .	9.86	197.20	39.44	20	
fat, . . . . .	5.81	116.20	92.96	80	
protein (nitrogenous matter), . . . . .	18.60	372.00	327.36	88	
nitrogenous extract matter, . . . . .	58.33	1,166.60	933.28	80	
	100.00	2,000.00	1,393.04	—	

*Wheat Bran.*

[Amherst Mill.]

47.64 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
ture at 100° C., . . .	10.14	202.80	—	—	} 1:3.73
matter, . . . . .	89.86	1,797.20	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
le ash, . . . . .	7.11	142.20	—	—	
cellulose, . . . . .	10.57	211.40	42.28	20	
fat, . . . . .	5.38	107.60	86.08	80	
protein (nitrogenous matter), . . . . .	18.23	364.60	320.85	88	
nitrogenous extract matter, . . . . .	58.71	1,174.20	939.36	80	
	100.00	2,000.00	1,388.57	—	

## 118 AGRICULTURAL EXPERIMENT STATION. [Jan.

*Wheat Bran.*

[Amherst Mill.]

48.85 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	11.52	230.40	-	-	1:3.70
Dry matter, . . . . .	88.48	1,769.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	7.13	142.60	-	-	
“ cellulose, . . . . .	10.63	212.60	42.52	20	
“ fat, . . . . .	5.62	112.40	89.92	80	
“ protein (nitrogenous matter), . . . . .	18.36	367.20	323.14	88	
Non-nitrogenous extract matter, . . . . .	58.26	1,165.20	932.16	80	
	100.00	2,000.00	1,387.74	-	

*Wheat Bran.*

[Amherst Mill.]

20.04 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	12.69	253.80	-	-	1:3.38
Dry matter, . . . . .	87.31	1,746.20	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	7.06	141.20	-	-	
“ cellulose, . . . . .	14.01	280.20	56.04	20	
“ fat, . . . . .	5.47	109.40	87.52	80	
“ protein (nitrogenous matter), . . . . .	19.19	383.80	337.74	88	
Non-nitrogenous extract matter, . . . . .	54.27	1,085.40	868.32	80	
	100.00	2,000.00	1,349.62	-	

*Wheat Shorts.*

[Two samples, sent on by C. A. Newhall, Lynn, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	8.87	10.33
Dry matter, . . . . .	91.13	89.67
	100.00	100.00
<i>Analysis of Dry Matter.</i>		
Ash, . . . . .	7.14	7.96
Cellulose, . . . . .	8.58	11.21
Fat, . . . . .	5.86	5.52
Protein (nitrogenous matter), . . . . .	16.71	17.28
Non-nitrogenous extract matter, . . . . .	61.71	58.03
	100.00	100.00
Passed screen 144 meshes to square inch, . . . . .	52.60	55.00

*Wheat Shorts.*

[Sent on by W. F. Williams, South Amherst, Mass.]

	PER CENT	
	Winter Bran.	Summer Bran.
Moisture at 100° C., . . . . .	7.42	7.87
Dry matter, . . . . .	92.58	92.13
	100.00	100.00
<i>Analysis of Dry Matter.</i>		
Ash, . . . . .	7.19	6.82
Cellulose, . . . . .	8.01	9.87
Fat, . . . . .	5.75	5.86
Protein (nitrogenous matter), . . . . .	18.09	17.77
Non-nitrogenous extract matter, . . . . .	60.96	59.68
	100.00	100.00
Passed screen 144 meshes to square inch, . . . . .	60.40	61.20



# 120 AGRICULTURAL EXPERIMENT STATION. [Jan.

## Old-process Linseed Meal.

76.40 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . . .	8.72	174.40	-	-	1:1.93
Dry matter, . . . . .	91.28	1,825.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	5.96	119.20	-	-	
“ cellulose, . . . . .	8.23	164.60	42.79	26	
“ fat, . . . . .	9.87	197.40	179.63	91	
“ protein (nitrogenous matter), . . . . .	36.19	723.80	629.70	87	
Non-nitrogenous extract matter, . . . . .	39.75	795.00	723.45	91	
	100.00	2,000.00	1,575.57	-	

## Fertilizing Constituents of Old-process Linseed Meal.

	Per Cent.
Moisture at 100° C., . . . . .	8.72
Ash, . . . . .	5.44
Calcium oxide, . . . . .	0.68
Magnesium oxide, . . . . .	0.69
Sodium oxide, . . . . .	0.86
Ferric oxide, . . . . .	0.05
Potassium oxide (4½ cents per pound), . . . . .	1.37
Phosphoric acid (6 cents per pound), . . . . .	2.17
Nitrogen (17 cents per pound), . . . . .	5.29
Insoluble matter, . . . . .	0.31
Valuation per ton, . . . . .	\$21.75

*Old-process Linseed Meal.*

87.40 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
are at 100° C., . . .	9.30	186.00	-	-	1:1.78
matter, . . . . .	90.70	1,814.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
ash, . . . . .	7.70	154.00	-	-	
cellulose, . . . . .	8.96	179.20	46.59	26	
fat, . . . . .	6.50	130.00	118.30	91	
protein (nitrogenous matter), . . . . .	35.27	705.40	613.09	87	
nitrogenous extract ter, . . . . .	41.57	831.40	756.57	91	
	100.00	2,000.00	1,534.55	-	

*Old-process Linseed Meal.*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
are at 100° C., . . .	11.50	230.00	-	-	1:1.50
matter, . . . . .	88.50	1,770.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
ash, . . . . .	6.08	121.60	-	-	
cellulose, . . . . .	8.64	172.80	44.93	26	
fat, . . . . .	6.43	128.60	117.03	91	
protein (nitrogenous matter), . . . . .	39.97	799.40	695.48	87	
nitrogenous extract ter, . . . . .	38.88	777.60	707.62	91	
	100.00	2,000.00	1,565.06	-	

*New-process Linseed Meal.*

58.84 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	5.06	101.20	-	-	1 : 1.26
Dry matter, . . . . .	94.94	1,898.80	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.34	126.80	-	-	
“ cellulose, . . . . .	8.93	178.60	46.43	26	1 : 1.26
“ fat, . . . . .	2.17	43.40	39.49	91	
“ protein (nitrogenous matter), . . . . .	41.02	820.40	713.74	87	
Non-nitrogenous extract matter, . . . . .	41.54	830.80	756.02	91	
	100.00	2,000.00	1,555.68	-	

*New-process Linseed Meal.*

47.35 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	11.83	236.60	-	-	1 : 1.376
Dry matter, . . . . .	88.17	1,763.40	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.43	128.60	-	-	
“ cellulose, . . . . .	9.01	180.20	48.65	26	1 : 1.376
“ fat, . . . . .	3.15	63.00	57.33	91	
“ protein (nitrogenous matter), . . . . .	39.91	798.20	694.43	87	
Non-nitrogenous extract matter, . . . . .	41.50	830.00	755.30	91	
	100.00	2,000.00	1,555.71	-	

*New-process Linseed Meal.*

55.60 per cent. passed screen 144 meshes to square inch.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	8.29	165.80	-	-	1:1.74
Matter, . . . . .	91.71	1,834.20	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Ash, . . . . .	5.91	118.20	-	-	
Cellulose, . . . . .	9.43	188.60	49.04	26	
Fat, . . . . .	4.08	81.60	74.26	91	
Protein (nitrogenous matter), . . . . .	35.03	700.60	609.51	87	
Non-nitrogenous extract matter, . . . . .	45.55	911.00	829.01	91	
	100.00	2,000.00	1,561.82	-	

*Fertilizing Constituents of New-process Linseed Meal.*

	Per Cent.
Moisture at 100° C., . . . . .	8.29
Matter, . . . . .	5.42
Calcium oxide, . . . . .	0.96
Magnesium oxide, . . . . .	0.63
Phosphoric oxide, . . . . .	0.06
Potassium oxide (4½ cents per pound), . . . . .	1.57
Phosphoric acid (6 cents per pound), . . . . .	1.80
Nitrogen (17 cents per pound), . . . . .	5.14
Soluble matter, . . . . .	0.17
Cost per ton, . . . . .	\$20 97

*Cotton-seed Meal.*

[Sent on by E. H. McIntosh, Needham, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	10.50
Matter, . . . . .	89.50
	100.00
<i>Analysis of Dry Matter.</i>	
Ash, . . . . .	8.47
Cellulose, . . . . .	10.40
Fat, . . . . .	9.57
Protein (nitrogenous matter), . . . . .	46.92
Non-nitrogenous extract matter, . . . . .	24.64
	100.00
Passed screen 144 meshes to square inch, . . . . .	66.24

*Fertilizing Constituents of Cotton-seed Meal.*

	Per Cent.
Moisture at 100° C., . . . . .	10.500
Calcium oxide, . . . . .	0.295
Magnesium oxide, . . . . .	0.721
Sodium oxide, . . . . .	0.249
Potassium oxide, . . . . .	1.830
Nitrogen, . . . . .	6.720
Phosphoric acid, . . . . .	2.350
Insoluble matter, . . . . .	0.390

*Sea Island Cotton-seed Meal (Ground with Hulls on).*

[Sent on by Butler, Breed &amp; Co., Boston, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	11.62
Dry matter, . . . . .	88.38
	<hr/> 100.00

*Analysis of Dry Matter.*

Crude ash, . . . . .	12.07
“ cellulose, . . . . .	20.04
“ fat, . . . . .	8.90
“ protein (nitrogenous matter), . . . . .	26.07
Non-nitrogenous extract matter, . . . . .	32.92
	<hr/> 100.00
Passed screen 144 meshes to square inch, . . . . .	52.72

*Fertilizing Constituents of the Above.*

	Per Cent.
Moisture at 100° C., . . . . .	11.62
Calcium oxide, . . . . .	0.57
Magnesium oxide, . . . . .	0.60
Potassium oxide (4½ cents per pound), . . . . .	1.31
Phosphoric acid (6 cents per pound), . . . . .	2.09
Nitrogen (15 cents per pound), . . . . .	3.59
Insoluble matter, . . . . .	0.57
Valuation per ton, . . . . .	\$14 46

*Gluten Meal (Chicago).*

[Springfield, Mass.]

56.40 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	10.45	209.00	—	—	1:2.11
Matter, . . . . .	89.55	1,791.00	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Ash, . . . . .	0.85	17.00	—	—	
Cellulose, . . . . .	0.67	13.40	5.55	34	
Fat, . . . . .	12.05	241.00	183.16	76	
Protein (nitrogenous matter), . . . . .	38.17	763.40	648.89	85	
Nitrogenous extracter, . . . . .	48.26	965.20	907.29	94	
	100.00	2,000.00	1,744.89	—	

*Gluten Meal.*

[Springfield, Mass.]

54.10 per cent. passed screen 144 meshes to square inch.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	6.50	130.00	—	—	1:2.37
Matter, . . . . .	93.50	1,870.00	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Ash, . . . . .	0.68	13.60	—	—	
Cellulose, . . . . .	0.68	13.60	4.62	34	
Fat, . . . . .	10.03	204.60	155.49	76	
Protein (nitrogenous matter), . . . . .	35.02	700.40	588.34	85	
Nitrogenous extracter, . . . . .	53.39	1,067.80	1,003.73	94	
	100.00	2,000.00	1,752.18	—	

*Gluten Meal.*

[I., sent on by S. N. Fletcher, South Acton, Mass.; II., sent on by J. L. Smith, Barre, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	7.30	10.00
Dry matter, . . . . .	92.70	89.00
	100.00	100.00
<i>Analysis of Dry Matter.</i>		
Crude ash, . . . . .	1.32	2.00
“ cellulose, . . . . .	1.14	6.00
“ fat, . . . . .	17.60	11.00
“ protein (nitrogenous matter), . . . . .	39.77	26.00
Non-nitrogenous extract matter, . . . . .	40.17	51.00
	100.00	100.00
Passed screen 144 meshes to square inch, . . . . .	84.80	65.00

*Fertilizing Constituents of Gluten Meal.*

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	7.300	10.00
Calcium oxide, . . . . .	0.051	0.00
Magnesium oxide, . . . . .	0.035	0.00
Ferric oxide, . . . . .	0.070	0.00
Sodium oxide, . . . . .	0.018	0.00
Potassium oxide (4½ cents per pound), . . . . .	0.045	0.00
Phosphoric acid (6 cents per pound), . . . . .	0.429	0.00
Nitrogen (17 cents per pound), . . . . .	5.900	3.00
Valuation per ton, . . . . .	\$20 61	\$14 00

*Buckwheat Middlings.*

[Sent on by J. A. Cunningham, Bolton, Mass.]

Moisture at 100° C., . . . . .		
Dry matter, . . . . .		

*Analysis of Dry Matter.*

	Per Cent.
ash, . . . . .	5.44
cellulose, . . . . .	5.18
fat, . . . . .	7.53
protein (nitrogenous matter), . . . . .	25.49
nitrogenous extract matter, . . . . .	56.86
	100.00

71.40 per cent. passed screen 144 meshes to square inch.

*Wheat Middlings.*

[Sent on by F. H. Willaims, Sunderland, Mass.]

	Per Cent.
ash at 100° C., . . . . .	12.43
matter, . . . . .	87.57
	100.00

*Analysis of Dry Matter.*

ash, . . . . .	4.21
cellulose, . . . . .	5.78
fat, . . . . .	3.38
protein (nitrogenous matter), . . . . .	15.13
nitrogenous extract matter, . . . . .	71.50
	100.00

94.16 per cent. passed screen 144 meshes to square inch.

*Corn Fodder (Pride of the North).*

[East Fields, collected Sept. 4, 1889.]

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
ash at 100° C., . . . . .	74.68	1,593.60	—	—	1:9.24
matter, . . . . .	25.32	506.40	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
ash, . . . . .	7.40	148.00	—	—	
cellulose, . . . . .	20.11	402.20	289.58	72	
fat, . . . . .	1.65	33.00	24.75	75	
protein (nitrogenous matter), . . . . .	8.31	166.20	128.62	73	
nitrogenous extract matter, . . . . .	62.53	1,250.60	837.90	67	
	100.00	2,000.00	1,280.85	—	





*Corn Stover (Pride of the North).*

[Experiment Station, 1890.]

	Percentage Com- position.	Constituents (in pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
ture at 100° C., . . .	21.76	435.20	-	-	1:8.61
matter, . . . . .	78.24	1,564.80	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
e ash, . . . . .	3.97	79.40	-	-	
cellulose, . . . . .	34.96	699.20	503.42	72	
fat, . . . . .	1.54	30.80	23.10	75	
protein (nitrogenous matter), . . . . .	9.76	195.20	142.50	73	
nitrogenous extract matter, . . . . .	49.77	995.40	666.92	67	
	100.00	2,000.00	1,335.94	-	

*Ensilage Corn (Pride of the North).*

[Sept. 8, 1890.]

ture at 100° C., . . . . .	Per Cent.
matter, . . . . .	9.42
	90.58
	100.00

*Analysis of Dry Matter.*

e ash, . . . . .	6.01
cellulose, . . . . .	23.03
fat, . . . . .	2.76
protein (nitrogenous matter), . . . . .	9.31
nitrogenous extract matter, . . . . .	58.89
	100.00

*Ensilage of Soja Bean and Cow-pea.*

[Station, 1889.]

ture at 100° C., . . . . .	Per Cent.
matter, . . . . .	69.78
	30.22
	100.00

### *Analysis of Dry Matter.*

### *Fertilizing Constituents of Soja Bean and Cow-pea Ensilage.*

### *Ensilage of Red-cob Corn.*

[Station, 1889.]

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.
Moisture at 100° C., . . .	74.48	1,489.60	-	-
Dry matter, . . . . .	25.52	510.40	-	-
	100.00	2,000.00	-	-
<i>Analysis of Dry Matter.</i>				
Crude ash, . . . . .	6.55	131.00	-	-
" cellulose, . . . . .	28.48	569.60	410.11	72
" fat, . . . . .	4.81	96.20	72.15	75
" protein (nitrogenous matter), . . . . .	6.55	131.00	95.63	73
Non-nitrogenous extract matter, . . . . .	53.61	1,072.20	718.37	67
	100.00	2,000.00	1,296.26	-

*Ensilage of Pride of North Corn.*

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.	
Temperature at 100° C., . . .	71.41	1,428.20	-	-	} 1:10.17.	
Dry matter, . . . . .	28.59	571.80	-	-		
	100.00	2,000.00	-	-		
<i>Analysis of Dry Matter.</i>						
Ash, . . . . .	6.41	128.20	-	-		
Cellulose, . . . . .	24.19	483.80	348.34	72		
Fat, . . . . .	5.53	110.60	82.95	75		
Protein (nitrogenous matter), . . . . .	8.72	174.40	127.31	78		
Nitrogenous extract matter, . . . . .	55.15	1,103.00	739.01	67		
	100.00	2,000.00	1,297.61	-		

*Imported Seed of Scotch Tares.*

Temperature at 100° C., . . . . .	Per Cent.
Dry matter, . . . . .	14.26
	85.74
	100.00

*Analysis of Dry Matter.*

Ash, . . . . .	4.15
Cellulose, . . . . .	3.87
Fat, . . . . .	7.38
Protein (nitrogenous matter), . . . . .	32.08
Nitrogenous extract matter, . . . . .	52.52
	100.00

*Fertilizing Constituents of the Above.*

Temperature at 100° C., . . . . .	14.26
Carbon oxide, . . . . .	0.20
Potassium oxide, . . . . .	0.14
Silica oxide, . . . . .	0.02
Iron oxide, . . . . .	0.40
Sodium oxide, . . . . .	1.29
Phosphoric acid, . . . . .	1.02
Nitrogen, . . . . .	4.24
Insoluble matter, . . . . .	0.04
Total value per ton, . . . . .	\$16 74

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## *Vetch and Oats.*

[Station, collected July 23, 1890.]

Moisture at 100° C., . . . . .	7
Dry matter, . . . . .	92

## *Analysis of Dry Matter.*

Crude ash, . . . . .	8
“ cellulose, . . . . .	5
“ fat, . . . . .	10
“ protein (nitrogenous matter), . . . . .	4
Non-nitrogenous extract matter, . . . . .	10

## *Fertilizing Constituents of Vetch and Oats.*

Moisture at 100° C., . . . . .	
Calcium oxide, . . . . .	
Magnesium oxide, . . . . .	
Ferric oxide, . . . . .	
Sodium oxide, . . . . .	
Potassium oxide, . . . . .	
Phosphoric acid, . . . . .	
Nitrogen, . . . . .	
Insoluble matter, . . . . .	
Valuation per ton, . . . . .	

## *Royal English Horse and Cattle Condiment.*

[I., from S. N. Thompson, Southborough, Mass.; II., from C. H. Heywood, Holyoke, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	10.80	10
Dry matter, . . . . .	89.70	89
	100.00	100
<i>Analysis of Dry Matter.</i>		
Crude ash, . . . . .	6.53	8
“ cellulose, . . . . .	3.59	4
“ fat, . . . . .	6.23	5
“ protein (nitrogenous matter), . . . . .	14.21	13
Non-nitrogenous extract matter, . . . . .	69.44	67
	100.00	100

# *Harvey's Universal Vegetable Food.*

[Sent on by E. F. Richardson, Millis, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	11.18
Dry matter, . . . . .	88.82
	<hr/>
	100.00
<i>Analysis of Dry Matter.</i>	
Ash, . . . . .	4.59
Cellulose, . . . . .	7.06
Fat, . . . . .	3.03
Protein (nitrogenous matter), . . . . .	15.34
Nitrogenous extract matter, . . . . .	69.98
	<hr/>
	100.00
Passed screen 144 meshes to square inch, . . . . .	72.98

## *Methods of Analysis of Cattle Foods.*

1. *Moisture.* — Dry 2 grams in an air-bath at 100–110° to a constant weight.

2. *Ash.* — Char 2 to 5 grams in a muffle furnace at a low heat, cool and weigh. Digest for a short time with dilute hydrochloric acid; collect the residue insoluble in acid in a Gooch crucible, wash, dry and weigh. Subtract this from the total weight for pure ash.

3. *Ether Extract.* — Dry 2 grams at 100° C. for two hours. Exhaust with anhydrous, alcohol-free ether, until the extraction is complete. Dry the extract in the air-bath at 100° C. to a constant weight.

4. *Crude Protein.* — Determine nitrogen by the Kjeldahl method, soda-lime method, and multiply the result by 6.25 for crude protein.

5. *Albuminoid Nitrogen.* — Determine by Stutzer's method, as given in the "Proceedings of the Association of Official Agricultural Chemists," 1889 (pages 226 and 227), except that the protein-copper is dried before being introduced into the flask.

6. *Crude Fibre, or Cellulose.* — The Weende method, as described in the "Proceedings of the Association of Official Agricultural Chemists," 1888 (page 70). In this method 5 grams of the material, having been nearly or completely freed from fat, are boiled for thirty minutes with 200 cubic

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centimetres of  $1\frac{1}{4}$  per cent. sulphuric acid, brought up  
linen filter and thoroughly washed with boiling water.  
then washed into the boiling-flask with a  $1\frac{1}{4}$  per cent.  
tion of sodium hydrate, brought quickly to  $100^{\circ}$  C.  
boiled for thirty minutes, when it is filtered through  
Gooch crucible, or balanced filter-papers, washed with  
boiling water, alcohol and ether, dried at  $100^{\circ}$  C. for an  
and weighed. The organic matter is then burned off  
the weight of the ash deducted for crude cellulose.

## ON FIELD EXPERIMENTS.

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I. Some suggestions regarding the question, How can we improve in an economical way the productiveness of our farm lands?

I. Experiments to ascertain the effect of different combinations of nitrogen, nitrate of soda, sulphate of ammonia and other nitrogen-containing materials, blood, as well as the absence of nitrogen-containing manurial matter, under otherwise corresponding circumstances, on oats. (Field A.)

II. Field experiments with prominent grasses and leguminous plants, to study their composition and general economical value in our section of the country. (Field B.)

III. Field experiments with reputed field and garden crops, to ascertain their adaptation to our soil and climate. (Fields C and D.)

IV. Field experiments to study the economy of using different commercial sources of phosphoric acid for manurial purposes in practice. (Potatoes. Field F.)

V. Experiments with grass land. (East Field Meadow.)

VI. Report on general farm work.

VII. Professor Humphrey's report. (On diseases of farm animals.)

### SOME SUGGESTIONS REGARDING THE QUESTION, HOW CAN WE IMPROVE IN AN ECONOMICAL WAY THE PRODUCTIVENESS OF OUR FARM LANDS?

An insufficient supply of suitable manurial matter, required for the successful and liberal production of the crops to be raised, is at present universally recognized as being the most fatal circumstance in any system of farming for profit. Adopting this conclusion as the correct verdict of past and present experience in agricultural industries, it becomes most desirable, in the interest of satisfactory pecuniary returns, that every available manurial resource of the farm should be turned to account to its full extent. To secure



this end we are advised to begin the work with a thorough, mechanical preparation of the soil under cultivation; to select the crops to be raised, as far as practicable with reference to their tendency of economizing existing natural resources of plant-food; to increase the latter to the full extent of suitable home-made manure on hand, and to supplement the latter liberally by buying commercial concentrated fodder articles and commercial fertilizer, as far as circumstances advise. To discuss briefly some of the means of developing and economizing manurial sources on the farm, is one of the objects of this communication. On the present occasion only two of those means will be discussed, which, although more or less at the disposition of every farmer engaged in mixed farm management, are frequently do not receive that degree of consideration which they deserve, namely:—

1. A judicious selection and a liberal production of fodder crops.
2. An economical system of feeding farm live stock.

### *1. Production and Selection of Fodder Crops.*

A careful inquiry into the history of agriculture, down to the middle of the present century, has shown that the original productiveness of farm lands in all civilized countries, even in the most favored localities, has suffered in the course of time a gradual decline. This general decline in the fertility of the soil under cultivation has been ascribed with much propriety in the majority of instances, mainly to two causes: namely, a gradual but serious reduction in the area occupied by forage crops, natural pastures and meadows, and a marked decline in the annual yield of fodder crops on large tracts of land but ill suited for a permanent cultivation of grasses,—the main reliance of fodder production at the present time. A serious falling off in the annual yield of pastures and meadows was followed usually by a reduction in the number of live stock, which, in turn, caused a falling off in the principal home resource of manurial matter. This chapter in the history of farm management has repeated itself in many countries. The unsatisfactory results of that system

ing finds still an abundant illustration in the present  
usted condition of a comparatively large area of farm  
s in New England.

Scientific investigations, carried on during the past fifty  
s for the particular benefit of agriculture, have not only  
instrumental in recognizing the principal causes of an  
st universal periodical decline of the original fertility of  
lands, but have also materially assisted, by field experi-  
s and otherwise, in introducing efficient remedies to  
t the noted decline in the annual yield of our most  
inent farm crops. As a scanty supply of manurial  
er, due to a serious falling off of one of the principal  
er crops, was found to be one of the chief causes of less  
enerative crops, and thus indirectly has proved to be the  
cause of an increase in the cost of the products of the  
al industry of the farm, — milk and meat, — it is but  
ral that the remedies devised should include, as one of  
premost recommendations, a more liberal production of  
itious fodder crops. The soundness of this advice is to-  
tally demonstrated in the most successful agricultural  
ns of the world. An intensive system of cultivation  
replaced in those localities the extensive one of pre-  
g periods; although the area under cultivation for the  
uction of general farm crops has been reduced, the  
value of products of the farm have increased materially,  
onsequence of a more liberal cultivation of reputed  
er crops. The change has been gradual, and the results  
ighly satisfactory.

ewing our own present condition, we notice that well-  
g grass land, good natural meadow, with rich and  
sive pastures, are rather an exception than the rule.  
benefits derived from indifferently yielding natural  
res are more apparent than real; the low cost of the  
uction of the fodder is frequently, in a large degree, set  
y a mere chance distribution of the manure produced.  
ntinued cultivation of one and the same crop upon the  
land, without a liberal, rational system of manuring,  
aused in many instances a one-sided exhaustion of the  
under cultivation. This circumstance has frequently  
brought about, in a marked degree, by a close

rotation of mixed grasses (meadow growth) and the next main reliance for fodder, — the corn (maize). These crops require potash and phosphoric acid, in similar proportion (4, potassium oxide, to 1, phosphoric acid) and both require an exceptional amount of the former. It is a good reason to assume that the low state of productivity of many of our farms, so often complained of, is largely due to the fact that crops have been raised in successive years, which, like those mentioned, have consumed the other essential article of plant food in an exceptional large proportion, and thereby have gradually unfitted the soil for their remunerative production; while a liberal supply of other important articles of plant food is left in the soil behind. As the amount of available plant food contained in the soil represents largely the working capital of the farmer, it cannot be otherwise but that the practice of allowing a part of it to lie idle must reduce the interest of the farmer in investment.

Our personal observation upon the lands assigned for the use of the station has furnished abundant illustration of the above-described condition of farm lands. In one instance it was noticed that a piece of old, worn-out grass land, after being turned under and properly prepared, as far as the mechanical condition of the soil was concerned, produced, without any previous application of manure, an exceptional large crop of horse-beans and lupine, — two reputed fertilizer crops. A similar observation was made during the present season, when lands, which for years had been used for the production of English hay and corn, were used for the cultivation of southern cow-pea, serradella, and a mixed crop of oats and vetch, to serve as green fodder for milch cows. The field engaged for the production of these crops was not manured, because it was to be prepared for a special fertilizer experiment during the present season. An area of 100 acres of land, which, under favorable circumstances, would produce more than six tons of green grass at the time of blooming, yielded nine to ten tons of green vetch and ten tons of green southern cow-pea, and from twelve to thirteen tons of green serradella. The exceptional exhaustion of our lands in potash has been shown by detailed de-

of experiments with fodder corn in previous annual reports.

The results obtained during past years tend to confirm the opinion held by successful agriculturists, that dry grass lands which are in an exceptional degree inclined to a spontaneous overgrowing by an inferior class of fodder plants and weeds, are not at all fit for a more thorough system of cultivation, ought to be turned by the plough and subsequently planted with the hoed crop, to kill off the foul growth and to improve the physical and chemical condition of the soil. These lands prove, in many instances, ultimately a far better investment when used for the raising of other farm crops than grasses. The less the variety of crops raised in succession upon the same lands, the more one-sided is usually the exhausted soil, and the sooner, as a rule, will be noticed a decrease in the annual yield. The introduction of a greater variety of fodder plants enables us to meet better the differences in local conditions of climate and of soil, as well as the special wants of different branches of farm industry. In choosing plants for that purpose, it seems advisable to select crops which would advantageously supplement our leading fodder crop (aside from the products of pastures and meadows),—the timothy, clover, and corn stover.

Taking this view of the question, the great and valuable family of leguminous plants, as clovers, vetches, lucerne, radella, peas, beans, lupines, etc., is, in a particular degree, well qualified for that purpose. They deserve also a decided recommendation in the interest of a wider range, the introduction of economical systems of rotation, under various conditions of soil and different requirements of markets. Most of these fodder plants have an extensive root system, and for this reason largely draw their plant food from the lower portion of the soil. The amount of stubble and roots they leave behind after the crop has been harvested is exceptionally large, and decidedly improves the physical and chemical condition of the soil. The lands are consequently better fitted for the production of slow-growing crops, as grains, etc. Large productions of fodder crops assist in the economical raising of general farm crops; although the area devoted to cultivation is

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reduced, the total yield of the land is usually more factory.

The subsequent tabular statement contains a list of crops raised on the lands of the station. Those with \* have been tried successfully on a large scale for fodder; the remainder seem to be well adapted to the climate. All are reported in their *dry* state, to compare their relative nutritive character, as well as the value of their fertilizing constituents. For further details see the seventh annual report, for 1889.

NAME OF CROP. (SUITABLE FOR FEEDING.)	Nutritive Ratio.	FODDER CONSTITUENTS (IN POUNDS) IN 1,000 POUNDS OF DRY MATTER.						FERTILIZING CONSTITUENTS (IN POUNDS) IN 1,000 POUNDS OF DRY MATTER.			Manurial Value per Ton of Dry Matter.
		Crude Ash.	Crude Cellulose.	Crude Fat.	Crude Protein (Nitrogenous Matter).	Non-nitrogenous Extract Mat- ter.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.		
Medium clover ( <i>Trifolium pratense</i> ),	1 : 2.5	89.0	299.7	26.2	146.3	438.8	23.40	4.88	24.65	\$10 64	
Alsike clover ( <i>Trifolium hybridum</i> ),		116.7	261.8	26.6	162.2	432.7	25.88	7.81	24.72	11 86	
*Cow-pea ( <i>Dolichos</i> ),	to	69.2	235.9	24.8	145.9	524.2	23.40	5.79	14.44	9 86	
*Serradella ( <i>Ornithopus sativus</i> ),		116.9	324.9	23.7	149.6	384.9	23.94	8.04	24.12	11 15	
*Vetch ( <i>Vicia sativa</i> ),	1 : 5.5	82.4	303.7	25.0	150.9	438.0	24.14	5.47	12.75	9 95	
*Soja bean ( <i>Soja hispida</i> ),		75.1	212.6	59.9	154.0	497.5	24.78	4.66	16.53	10 89	
Lucerne ( <i>Medicago sativa</i> ),	}	81.1	297.2	16.5	142.2	463.0	22.75	5.61	15.59	9 73	
*Herds grass ( <i>Phleum pratense</i> ),		53.3	328.7	20.1	85.2	512.7	13.95	4.97	16.54	6 75	
*Corn stover,	}	50.3	320.2	16.5	79.2	533.8	12.67	4.22	18.39	6 38	
*Fodder corn,		48.8	314.0	15.3	72.1	549.8	11.54	7.98	10.99	5 75	
*Oats (entire plant),	1 : 5.5	60.8	343.2	26.9	108.9	460.2	17.42	7.81	22.90	8 81	
Barley (entire plant),		49.5	291.2	27.6	102.6	529.1	16.42	6.44	19.53	8 02	
Millet,	1 : 9.5	54.9	335.4	17.4	75.9	516.4	12.14	5.03	10.89	5 66	
Hungarian grass ( <i>Scleria italica</i> ),		71.5	246.6	10.1	93.8	578.0	15.01	6.24	13.50	7 00	
Japanese buckwheat,	}	123.6	360.2	22.2	108.0	386.0	17.28	9.04	35.21	9 95	
*Sugar beets,		46.4	60.0	6.5	108.4	778.7	17.34	5.41	18.57	8 12	
*Rufa-bagas,	1 : 9.5	97.5	118.3	15.3	110.1	658.8	17.62	10.76	41.05	10 77	
*Mangel-wurzels,		90.6	79.4	8.8	103.7	717.5	16.59	7.32	30.13	9 08	
*Carrots,	1 : 13.	81.4	95.3	25.0	88.4	709.9	14.14	10.02	54.11	10 61	

## 2. *Economical Feeding of Farm Live Stock.*

The adoption of an economical system of feeding farm stock in the case of a mixed farm management is second in importance, as far as financial success is concerned to the remunerative production of the leading farm crop. The benefits derived from a successful management of the latter are not unfrequently largely offset by a mismanagement of the former. Comparatively recent investigations regarding the principles which control success in feeding farm live stock for various purposes, have greatly improved our chances for profit. Although much needs still to be learned in regard to many details, it is quite generally conceded that some important facts, bearing on the economic side of the question, have been fairly established.

The introduction of the chemical analysis of fodder and manure has made us more familiar with their general character. The influences which affect their composition are also better known. A fair knowledge in both directions is therefore considered indispensable for a due appreciation of the results obtained in feeding experiments. The latter, carried out under better-defined circumstances, have demonstrated an important fact that three distinctly different groups of substances are required for the support of the life of animals. These groups are: nitrogen-containing organic substances commonly called nitrogenous organic matter; non-nitrogenous organic matter, like sugar, starch, fat, etc.; and certain saline or mineral substances. Neither one nor any of these groups by themselves can for any length of time sustain animal life; nor can any excess of one or the other contained in the diet used, benefit the animal. The excess, as a rule, is ejected, and can only, if at all, benefit the soil as manure. We know, also, that all our farm plants contain more or less of each of the three essential groups of constituents. As no single plant or part of plant has power to any extent to furnish the most nutritious and at the same time the most economical diet for any particular class of animals, it becomes advisable to supplement them with other suitable articles, to secure their full benefit. The economical system of stock feeding has, therefore, to

select among the suitable fodder articles those which furnish the required quantity and proportion of the three essential food constituents in digestible form at the lowest cost. For more details regarding this point, I have to refer to previous annual reports.

Assuming a similar degree of adaptation of the various fodder articles offered for our choice, the question of cost becomes a serious consideration, when feeding for profit. The actual cost of a fodder article does not depend merely on its market price, but is materially affected by the value of the manurial refuse it leaves behind, when it has served its purpose as food. The higher the percentage of nitrogen, phosphoric acid and potash a diet contains, the more valuable the manure it furnishes, under otherwise corresponding circumstances. An excess, therefore, of any one or of all three in one diet, as compared with that of another, counts in favor of that particular diet, as far as the net cost of feed is concerned; for it is admissible, for mere practical economical purposes, to assume that, in raising one and the other kind of animals to a corresponding weight, or feeding them for the same purpose, a corresponding amount of nitrogen, phosphoric acid, potassium oxide, etc., will be obtained, and, according to circumstances, either stored up in the growing animal, or pass into the milk, etc. The commercial value of the three above-mentioned essential elements of plant food, contained in the manure secured in connection with our feeding experiments with milch cows, differed in case of different diets from less than one-third to more than one-half of the market cost of feed consumed. A few tabular statements may not be without interest on this occasion; for further illustration, I refer to our seventh annual report, — 1889.

Table showing the relative manurial value of stated fodder. Net cost signifies market cost, less manurial value. Tables designed to show the approximate relative cost per pound of digestible nitrogenous matter of some prominent fodder articles. The calculation assumes in every case a value of nine-tenths cents per pound of digestible non-nitrogenous extract matter, and four and one-half cents for digestible crude fat. The difference between



the sum of the money values of fat and non-nitrogenous extract matter and cellulose present, and the market value of the particular fodder articles, is charged to the digestible nitrogenous matter. The corn meal has been adopted as the basis for the comparison, as far as value of non-nitrogenous matter is concerned. In presenting this table it is by no means assumed that the nitrogenous matter, as shown below, is pound for pound of equal nutritive value. It merely aims to show what class of articles suggest themselves for trials, when an increase of nitrogenous matter is the main object for consideration in making up a class suitable for the occasion.

*1. Valuation of Fodder Articles (per Ton).*

	Market Cost.	Manurial Value.	Nitrogenous Matter.
Corn meal, . . . . .	\$20 00	\$7 50	
Wheat bran, . . . . .	17 00	14 50	
Wheat middlings, . . . . .	20 00	10 75	
Gluten meal, . . . . .	24 00	17 00	
Cotton-seed meal, . . . . .	26 00	19 75	
Linseed meal (old-process), . . . . .	27 00	21 75	
Linseed meal (new-process), . . . . .	25 00	24 00	
English hay (mixed), . . . . .	12 00	5 50	
Corn fodder, . . . . .	5 00	4 32	
Corn stover, . . . . .	5 00	4 80	
Sugar beets, . . . . .	5 00	1 15	
Mangel-wurzels, . . . . .	3 00	1 10	
Skim-milk, . . . . .	4 10	2 25	

[The constituents are given in pounds per 1,000 pounds of the substance which contains them.]

	Market Cost per Ton.	Moisture at 100° C.	Dry Matter.	Total Nitrogenous Matter.	Rate of Digestibility.	Digestible Nitrogenous Matter (Pounds).	Indigestible Nitrogenous Matter (Pounds).	Cost of Digestible Nitrogenous Matter per Pound, allowing for Cellulose and Fat Four and One-third Cents, for Cellulose and Non-nitrogenous Extract Matter Nine Cents, per Pound.	Total Nitrogen in Article.	Digestible Nitrogen.	Indigestible Nitrogen.
Corn meal, . . . . .	\$ 20 00	128.6	871.4	98.47	85	83.70	14.77	3.30	15.66	13.31	2.35
Wheat bran, . . . . .	17 00	109.7	890.3	158.86	84	139.86	19.00	2.21	25.33	22.29	3.04
Wheat middlings, . . . . .	20 00	95.5	901.5	164.71	88	144.94	19.77	3.08	26.35	23.19	3.16
Gluten meal, . . . . .	24 00	96.1	903.9	289.88	85	246.40	43.48	2.20	46.38	39.42	6.96
Cotton-seed meal, . . . . .	26 00	80.8	919.2	388.09	74	287.20	100.89	2.41	62.09	45.95	16.14
Linseed meal (old-process), . . . . .	27 00	74.8	925.2	843.70	87	299.02	44.68	2.60	54.99	47.84	7.15
Linseed meal (new-process), . . . . .	25 00	60.1	939.9	383.08	87	333.28	49.80	2.40	61.29	53.32	7.97
Timothy hay, . . . . .	12 00	85.7	914.3	75.97	57	43.80	32.67	8.10	12.15	6.93	6.22
English hay (mixed), . . . . .	12 00	97.2	902.8	86.13	57	49.09	37.04	8.09	13.78	7.85	5.93
Corn fodder, . . . . .	5 00	200.0	800.0	57.68	73	42.10	15.58	- *	9.23	6.74	2.49
Corn stover, . . . . .	5 00	162.7	837.3	68.74	73	50.18	18.56	- *	11.00	8.03	2.97
Sugar beets, . . . . .	5 00	835.2	164.8	19.17	100	19.17	0.00	6.47	3.07	3.07	0.00
Mangel-wurzel, . . . . .	8 00	877.5	122.5	12.70	100	12.70	0.00	4.52	2.03	2.03	0.00
Skim-milk, . . . . .	4 10	904.2	95.8	83.27	100	83.27	0.00	4.39	5.32	5.32	0.00

\* The digestible fat, cellulose and non-nitrogenous extract matter at stated prices more than cover the market cost.

*Corn Ensilage (Six Samples).*

[Sent on by J. H. Esterbrook for the Dudley Grange.]

*Statements of Parties.**a. Variety of corn : —*

1. Cross between Stowell's evergreen and eight-rowed variety.
2. Common field.
3. Eureka ensilage.
4. Southern white.
5. Stowell's evergreen.
6. Southern white.

*b. Fertilization per acre : —*

1. Three cords stable manure broadcast, with five hundred pounds ground bone in hill.
2. About thirty loads or ten cords stable manure broadcast, with two hundred pounds phosphate in hill.
3. Forty loads stable manure broadcast.
4. After a crop of rye for fodder, with five cords stable manure broadcast, four hundred pounds E. F. Coe's phosphate in drill.
5. Six cords horse manure, with three hundred pounds Braconer's fish in hill.
6. Two and one-half cords stable manure broadcast, with four hundred pounds sod in the fall, and ploughed in with four hundred pounds phosphate in drill when planting.

*c. Mode of planting : —*

1. Rows three feet apart; hills twenty-six inches apart; kernels to hill.
2. Rows three and a half feet apart; hills twenty inches apart; kernels to hill.
3. Rows three feet apart; hills twelve inches apart.
4. Rows three feet apart; kernels about three inches apart in drills.
5. Rows thirty-two inches apart; kernels about six inches apart in drills.
6. Rows three feet apart; kernels about one foot apart in drills.

*d. Period of harvesting : —*

1. Somewhat past the milk.
2. Over ripe; rather dry (September 23).
3. In the milk.
4. Ears commencing to form in the more exposed parts of the field.
5. Ears ripe enough for seed.
6. Past the milk (September 25).

*e. Yield per acre (approximately) : —*

1. Eighteen to twenty tons.

About eight tons of ensilage and eighty bushels of ears.

Estimated, thirty-five to forty tons; ten to fifteen feet high.

Twelve tons.

Twenty to twenty-two tons.

Twelve tons.

Mode of ensilaging : —

Cut in short pieces; silo filled in two days.

Cut in pieces one inch long.

Cut in short pieces by a Bailey cutter.

Cut in pieces one inch long by a Bailey cutter; covered with twelve inches of old hay or straw; then with inch boards and ten inches thickness of stones.

Cut in pieces three to four inches long by a Bailey cutter; silo filled in two days, covered and weighted.

Same as 4.

Odder analysis : —

Acidity calculated to Acetic Acid.	Moisture at 100° C.	Dry Matter.	ANALYSIS OF DRY MATTER, 100 PARTS.				
			Crude Ash.	Crude Cellulose.	Crude Fat.	Crude Protein (Nitrogenous Matter).	Non-nitrogenous Extract Matter.
Per Cent.	Per Cent.	Per Cent.					
3.68	76.38	23.62	6.18	20.05	5.57	8.49	59.71
2.12	70.01	29.99	6.74	34.97	2.74	5.98	49.57
1.98	82.87	17.13	7.22	38.92	1.82	6.04	46.00
2.69	75.36	24.64	6.25	30.26	2.57	6.52	54.40
1.27	78.84	21.16	6.94	24.40	3.78	7.53	57.35
1.13	71.65	28.35	4.37	24.64	2.68	6.82	61.49

*Observations made at the Laboratory.*

1. Best-looking sample, bright and fresh. Good per cent.

rs. Agreeable acid odor.

2. Odor and appearance not as good as No. 1. Smaller percent. of ears.

3. Small percent. of ears. Bright looking. Odor slightly

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No. 4. Fair per cent. of ears. Odor agreeable, but sour. Not so bright looking as No. 1.

No. 5. Larger per cent. of ears. Odor agreeable. Color Small weeds and grass mixed in.

No. 6. Fair per cent. of ears. Color not as bright as Smell, fair.

FIELD EXPERIMENTS TO ASCERTAIN THE EFFECT OF  
DIFFERENT COMBINATIONS OF NITROGEN, NITRATE  
OF SODA, SULPHATE OF AMMONIA AND ORGANIC-  
NITROGEN-CONTAINING COMPOUNDS, BLOOD, UNDER  
OTHERWISE CORRESPONDING CIRCUMSTANCES, ON  
OATS. 1890. (FIELD A.)

The area occupied by this experiment is the same which  
was reserved during four preceding years in succession — 1884  
to 1888 — for the purpose of ascertaining the extent of the  
exhausted natural resources of potash. The results obtained  
at that connection, which are described in our third, fourth,  
fifth and sixth annual reports, left no doubt about the fact  
that our farm land had been in an exceptional degree  
enriched in potash, in consequence of a too close  
rotation of grass and corn.

The field record of each of the ten plats, one-tenth of an  
acre in size, extended over a period of more than six years,  
and far as modes of cultivation and of manuring are con-  
cerned. Some plats had received during that period a supply  
of nitrogen for manurial purposes in but one and the same  
specified form, while others had received none in any form.  
The condition of the various plats was turned to proper  
account in our new plans.

1889 — Several plats which for five preceding years did  
not receive any nitrogen compound for manurial purposes,  
were retained in that state to study the effect of an entire  
exclusion of nitrogen-containing manurial substances on the  
crop under cultivation; while the remaining ones received,  
before, a definite amount of nitrogen in the same form in  
which they had received it in preceding years; namely,  
either as sodium nitrate or as ammonium sulphate, or as  
organic nitrogenous matter in form of dried blood. A  
corresponding amount of available nitrogen was applied  
in all these cases.

Aside from the difference regarding the nitrogen supply,  
all plats were treated alike. They each received, without  
exception, a corresponding amount of available phos-

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phoric acid and of potassium oxide. The phosphoric acid was supplied in form of dissolved bone-black, and potassium oxide either in form of muriate of potash or potash-magnesia sulphate. From 120 to 130 pounds of potassium oxide, from 80 to 85 pounds of available phosphoric acid, and from 40 to 50 pounds of available nitrogen were supplied per acre.

One plat, marked 0, received its main supply of phosphoric acid, potassium oxide and nitrogen in form of yard manure; the latter was carefully analyzed before applied, to determine the amount required to secure, as far as practicable, the desired corresponding proportions of essential fertilizing constituents. The deficiency in potassium oxide and phosphoric acid was supplied by potash-magnesia sulphate and dissolved bone-black. The fertilizer for plat 0 consisted of 800 pounds of barn-yard manure, 32 pounds of potash-magnesia sulphate, and 18 pounds of dissolved bone-black.

Plats 4, 7 and 9 received no nitrogen-containing manure substance; plats 1 and 2 received nitrogen in form of sodium nitrate; plats 5, 6 and 8 received nitrogen in form of ammonium sulphate; plats 3 and 10 received nitrogen in form of dried blood; plat 0 received nitrogen in form of barn-yard manure.

The entire field, eleven plats, was ploughed April 9. The fertilizer was applied broadcast to each plat, and was subsequently slightly harrowed under, April 27. The final preparation of the soil for seeding, by ploughing and harrowing, took place May 9. The same variety of corn (Clarke's flint corn, was planted in drills in a similar manner as during preceding years, May 10. The crop on all plats was kept clean by means of the cultivator and hoe; it was cut September 3, when the kernels were fairly glazed over.

*d of Corn Stover and Ears on Plats (1889), at Forty-eight  
Per Cent. Moisture.*

	Weight of Whole Crop.	Weight of Stover.	Weight of Ears.	Form of Nitrogen applied.
	Pounds.	Pounds.	Pounds.	
0, . . .	500.62	342.35	158.27	Barn-yard manure.
1, . . .	648.48	475.95	172.53	Nitrate of soda.
2, . . .	576.91	375.75	201.16	Nitrate of soda.
3, . . .	618.31	425.85	192.46	Blood.
4, . . .	381.18	283.90	97.28	No nitrogen.
5, . . .	488.01	359.05	128.96	Ammonium sulphate.
6, . . .	541.95	367.05	174.90	Ammonium sulphate.
7, . . .	525.82	484.30	41.52	No nitrogen.
8, . . .	359.12	237.98	121.14	Ammonium sulphate.
9, . . .	475.63	417.50	58.13	No nitrogen.
10, . . .	639.55	467.60	171.95	Dried blood.

*Percentage of Well-developed and Undeveloped Ears on Plats  
(1889).*

	Well-developed Ears.	Undeveloped Ears.
	Per Cent.	Per Cent.
0, . . . . .	60.3	39.7
1, . . . . .	48.5	51.5
2, . . . . .	46.7	53.3
3, . . . . .	28.3	71.7
4, . . . . .	14.7	85.3
5, . . . . .	18.7	81.3
6, . . . . .	29.0	71.0
7, . . . . .	41.6	58.4
8, . . . . .	21.3	78.7
9, . . . . .	24.4	75.6
10, . . . . .	50.2	49.8

The following tabular statement shows the general condition of the soil and its crop-producing quality during the years 1888 and 1889:—



## Field A.

NUMBER OF PLAT.	FERTILIZERS APPLIED.	YIELD OF DRY FODDER CORN.	
		1898.	1899.
Plat 1,	50 lbs. muriate of potash (= 25 lbs. potassium oxide),	617	648
Plat 2,	50 lbs. nitrate of soda (= 7 to 8 lbs. nitrogen),	303	577
Plat 3,	100 lbs. dissolved bone-black (= 17 lbs. available phosphoric acid).	150	618
Plat 4,	Nothing,	114	381
Plat 5,	97 lbs. magnesium sulphate,	564	488
Plat 6,	Nothing,	193	542
Plat 7,	50 lbs. muriate of potash (= 25 lbs. potassium oxide),	676	526
Plat 8,	50 lbs. ammonium sulphate (= 10 lbs. nitrogen),	146	359
Plat 9,	50 lbs. muriate of potash (= 25 lbs. potassium oxide),	533	476
Plat 10,	97 lbs. potash-magnesia sulphate (= 25 lbs. potassium oxide) and 60 lbs. dried blood (= 7 to 8 lbs. nitrogen).		

## FERTILIZERS APPLIED.

1898.

1899.

25 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid), . . .

29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid), . . .

43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid), . . .

25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid), . . .

22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid), . . .

22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid), . . .

25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid), . . .

22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid), . . .

25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid), . . .

22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid), . . .

25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid), . . .

43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid), . . .

the results of our first season of observation, 1889, revealing the influence of nitrogen-containing manurial substances on the character and on the quantity of the fodder raised under otherwise corresponding circumstances, although not without some interest, were not decisive enough to give a detailed explanation of causes. The larger part of the summer season of 1889 with us was cold and wet, and for this reason of an exceptionally unfavorable character for raising of fodder corn. How much this circumstance affected our first results, is difficult to decide. Not less difficult is it to decide, at this stage of observation, how far the special conditions of various plats may yet control the results. The comparatively low yield of ears and the low percentage of undeveloped ears, on plats 4, 7, 9, which received no nitrogen-containing manurial matter, was, however, very marked.

1890.— During the past season, oats was chosen as the crop for our trial. The field was prepared by ploughing in the fall and in the spring, previous to the manuring. The same kind and the same quantity of manurial substances were applied broadcast to the different plats as in the preceding year shortly before seeding.

NUMBER OF PLAT.	
0.	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black.
1.	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid.)
2.	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid.)
3.	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid.)
4.	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid.)
5.	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid.)
6.	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid.)
7.	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid.)
8.	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid.)
9.	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid.)
0.	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid.)

The above weights of the different manurial substances were taken for the purpose of securing to each plat, as practicable, potash, phosphoric acid and nitrogen in corresponding proportions.

The manurial substances were slightly harrowed before seeding. The oats were seeded April 29 and in rows, two feet apart, to allow a one-horse cultivation pass between the rows. Each plat had sixteen rows of thirty-nine pounds of oats, Pringle's Progress, with equal weights divided between eleven plats. A brush drill with no plate under the brush was used for that purpose.

The young plants appeared above ground on May 5. The plants on plats 6 and 8 appeared sickly, having a yellow tint, May 23. The entire field became subsequently somewhat infested with plant lice, plats 6 and 8 suffering May 26. Cultivator and hoe were used at this stage to renovate the ground, June 2 and 3. The entire crop, with the exception of that upon Plat 8, soon improved and recovered entirely. Plat 8 suffered for some days longer than the rest from the infection; it showed later on a more and somewhat uneven stand of its oats.

The shade of the green of the growth upon different plats showed during the progress of the season in many instances a quite marked difference. Upon plats which had received their nitrogen in the form of sulphate of ammonia, as upon those which had received no nitrogen-containing manurial matter, a light-green tint of the foliage was noticed alike in the earlier stages of the growth of the oats. In the latter case this light-green color of the foliage remained until the maturing began; in the former case, *i. e.*, where sulphate of ammonia had furnished the nitrogen supply, the color became deeper green as the season progressed.

The progress of growth varied at times in a marked degree, yet no exceptional differences in height were noticeable at the maturing of the crop.

The following tabular statement contains the measurements of the height of the plants at stated dates:—

	June 20 (Inches).	June 27 (Inches).	July 4 (Inches).	July 11 (Inches).	July 18 (Inches).	July 25 (Inches).
0, . . .	15	20	25	31	36	33
1, . . .	16	19	25	31	36	36
2, . . .	15	20	28	33	40	40
3, . . .	14	17	21	30	34	36
4, . . .	13	16	22	27	30	33
5, . . .	15	19	28	34	38	40
6, . . .	12	15	22	30	37	40
7, . . .	12	15	20	28	35	36
8, . . .	7	11	16	23	32	36
9, . . .	12	13	21	27	31	35
10, . . .	14½	19	24	32	40	40

The entire crop was cut August 11; it was removed to barn August 13. To secure as far as practicable a uniform state of dryness, the final weighing of the yield of each was deferred to August 21, when the following results were obtained:—

	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).
0, . . . . .	315	120	195
1, . . . . .	362	128	234
2, . . . . .	365	129	236
3, . . . . .	345	116	229
4, . . . . .	260	90	170
5, . . . . .	360	141	219
6, . . . . .	385	124	261
7, . . . . .	320	110	210
8, . . . . .	220	59	161
9, . . . . .	290	101	189
10, . . . . .	395	140	255
	3,617	1,258	2,359

Considering Plat 8 a failure for known cause, the low yield of kernels on plats 4, 7 and 9, which received no nitrogen application, is, to say the least, very significant.

*Comparative Weights and Moisture Tests of the A  
recorded Grains.*

One hundred average kernels of each plat were taken for the test; three independent tests were made; the values below recorded are the mean of the three tests made. The oats were kept in glass-stoppered bottles during the season.

PLATS.	Average Weight of 100 Kernels (Grams).	Average Per Cent. of Water.	Percent Dry Matter
0, . . . . .	3.2151	16.96	83.04
1, . . . . .	3.3577	17.58	82.42
2, . . . . .	3.1236	17.43	82.57
3, . . . . .	3.3260	20.88	79.12
4, . . . . .	3.2991	20.99	79.01
5, . . . . .	3.2015	18.79	81.21
6, . . . . .	3.1201	22.60	77.40
7, . . . . .	3.3956	22.22	77.78
8, . . . . .	3.0727	17.74	82.26
9, . . . . .	3.3408	23.94	76.06
10, . . . . .	3.0740	18.34	81.66

The difference in moisture points evidently toward the varying degree in maturity. In the majority of cases the muriate of potash has furnished the potassa, the maturity of the crop was somewhat later than where sulphate of potash was used.

PLAT.	Crop (Pounds).	Percentage of Grain.	Percentage of Straw and Chaff.	Dry Matter in Grain (Pounds).	Relative Percent- age of Dry Mat- ter in Grain.	ANALYSIS OF DRY MATTER	
						Potassium Oxide.	Phosphoric Acid.
						Per Cent.	Per Cent.
0, . . . . .	315	38.10	61.90	99.66	86.97	0.82	1.13
1, . . . . .	362	35.36	64.64	105.50	92.13	0.76	1.21
2, . . . . .	365	35.34	64.66	106.52	93.02	0.75	1.02
3, . . . . .	345	33.62	66.38	91.78	80.15	0.84	1.21
4, . . . . .	260	34.61	65.39	71.11	62.09	0.79	1.08
5, . . . . .	360	39.20	60.80	114.51	100.00	0.85	0.96
6, . . . . .	385	32.21	67.79	95.98	83.82	0.90	1.15
7, . . . . .	320	34.40	65.60	85.56	74.72	0.80	1.06
8, . . . . .	220	26.82	73.18	48.53	42.30	0.84	1.09
9, . . . . .	290	34.83	65.17	76.82	67.08	0.80	0.97
10, . . . . .	395	35.44	64.56	114.33	99.84	0.84	1.18
Average,	329	34.54	65.46				

The absence of nitrogen in the manurial matter applied to plats 4, 7, 9, is accompanied by the lowest yield in dry weight in the grain; the yield of dried grain in case of plats 4, 7, 9, averages 67.9 per cent., and in case of the remaining plats, excluding Plat 8 for stated reasons, it averages 90.8 per cent. The plats containing potash-magnesia sulphate as the potash source, namely, plats 2, 5, 10, have yielded the greatest amount of grain; each of these plats received its nitrogen supply in a different form, — ammonium sulphate, ammonium nitrate, and nitrate of soda. The field (A) has been seeded with winter rye during the late autumn, to continue the investigation in the same direction.

## FIELD "A" 1890.

10	43 lbs. Dried Blood. <del>48½ lbs. Potash Magnesia Sul.</del> 50 lbs. Dis. Bone Black.
9	25 lbs. Muriate of Potash. 50 lbs. Dis. Bone Black.
8	22½ lbs. Sulphate Ammonia. <del>25 lbs. Muriate of Potash.</del> 50 lbs. Dis. Bone Black.
7	25 lbs. Muriate of Potash. 50 lbs. Dis. Bone Black.
6	22½ lbs. Sulphate Ammonia. <del>25 lbs. Muriate of Potash.</del> 50 lbs. Dis. Bone Black.
5	22½ lbs. Sulphate Ammonia. <del>48½ lbs. Potash Magnesia Sul.</del> 50 lbs. Dis. Bone Black.
4	25 lbs. Muriate Potash. 50 lbs. Dis. Bone Black.
3	43 lbs. Dried Blood. <del>25 lbs. Muriate of Potash.</del> 50 lbs. Dis. Bone Black.
2	29 lbs. Nitrate of Soda. <del>48½ lbs. Potash Magnesia Sul.</del> 50 lbs. Dis Bone Black.
1	29 lbs. Nitrate of Soda. <del>25 lbs. Muriate of Potash.</del> 50 lbs. Dis. Bone Black.
0	800 lbs. Barnyard Manure. <del>32 lbs. Potash Magnesia Sul.</del> 18 lbs. Dis. Bone Black

FIELD EXPERIMENTS WITH PROMINENT FODDER CROPS, TO STUDY THEIR COMPOSITION AND THEIR GENERAL ECONOMICAL VALUE IN OUR SECTION OF THE COUNTRY. — GRASSES AND LEGUMINOUS PLANTS (FIELD B).

The field here under discussion is located west of Field described within some preceding pages. It occupies an of one and seven-tenths acres. The land is nearly , and the soil consists of a sandy loam several feet deep. In 1884 the entire field was subdivided into eleven plats of equal size, thirty-three by one hundred and seventy-five with five feet of space between them. Every alternate has received from that date annually the same kind and same amount of fertilizer, — six hundred pounds of and bones and two hundred pounds of muriate of potash per acre. Since 1885 all crops on that field have been raised in rows; this system of cultivation became a necessity in the case of grasses, clovers, etc., to secure a clean crop for preservation. The rows, in the case of corn and leguminous plants, were three feet and three inches apart; and, in the case of grasses, two feet. The space between the different rows has received, thus far, no manurial substance of any description, and is kept clean from vegetation by a proper weeding of the cultivator. Plats 11, 13, 15, 17, 19 and 21 were fertilized annually; plats 12, 14, 16, 18 and 20 have received no fertilizer until the season of 1889.

The details of the work carried on upon Field B are from year to year recorded in the annual report of the station. The chemical analyses of the crops raised require considerable time, on account of other contemporary pressing engagements in the laboratory, they are usually published in bulletins, and the reports of the succeeding year.

The subsequent tabular statement of crops raised upon the different plats of Field B since 1886 may assist in a more complete understanding of its late history, and its condition at the beginning of the season of 1890.



PLANTS.	1897.	1898.	1899.	1900.
Plat 11 (fertilized),	Corn, . . . . .	{ Kentucky blue-grass ( <i>Poa pratensis</i> ), . . .	{ Kentucky blue-grass, . . .	{ Kentucky blue-grass, sown Sept. 24, 1899.
Plat 12 (unfertilized),	Corn, . . . . .	{ Kentucky blue-grass, . . .	{ Kentucky blue-grass, . . .	{ Kentucky blue-grass, sown Sept. 24, 1899.
Plat 13 (fertilized),	{ Italian rye-grass ( <i>Lolium italicum</i> ), . . .	{ Italian rye-grass, . . .	{ Red-cob ensilage corn, . . .	{ Red top, sown Sept. 24, 1899.
Plat 14 (unfertilized),	{ English rye-grass ( <i>Lolium perenne</i> ), . . .	{ Italian rye-grass, . . .	{ Red-cob ensilage corn, . . .	{ Red top, sown Sept. 24, 1899.
Plat 15 (fertilized),	{ Italian rye-grass, . . .	{ English rye-grass, . . .	{ Bokhara clover ( <i>Medicago alba</i> ), . . .	{ Bokhara clover, sown May 8, 1899.
Plat 16 (unfertilized),	{ English rye-grass, . . .	{ Soja bean ( <i>Soja hispida</i> ), . . .	{ Sainfoin ( <i>Onobrychis sativa</i> ), . . .	{ Sainfoin, sown May 8, 1899.
Plat 17 (fertilized),	{ Five varieties Southern cow-pea, . . .	{ Soja bean, . . .	{ Sainfoin, . . .	{ Rhodo Island bent ( <i>Agratis alba</i> ), sown Sept. 25, 1899.
Plat 18 (unfertilized),	{ Five varieties Southern cow-pea, . . .	{ Meadow fescue, . . .	{ Meadow fescue, . . .	{ Meadow fescue, sown September, 1897.
Plat 19 (fertilized),	{ Meadow fescue ( <i>Festuca pratensis</i> ), . . .	{ Alsike clover, . . .	{ Red-cob ensilage corn, . . .	{ Meadow fescue, sown September, 1899.
Plat 20 (unfertilized),	{ Alsike clover, . . .	{ Alsike clover, . . .	{ Alsike clover, . . .	{ Herds grass, sown September, 1899.
Plat 21 (fertilized),	{ Medium red clover, . . .	{ Medium red clover, . . .	{ Medium red clover, . . .	{ Red top and herds grass, mixed, sown September, 1899.
	{ Mammoth red clover ( <i>Trifolium medium</i> ), . . .	{ Mammoth red clover, . . .	{ Red-cob ensilage corn, . . .	{ Red top and herds grass, mixed, sown September, 1899.
	{ Mammoth red clover, . . .	{ Alfalfa, . . .	{ Corn (variety, Clark), . . .	{ Meadow fescue and herds grass, mixed, sown September, 1899.
	{ Mammoth red clover, . . .	{ Alfalfa, . . .		

the fertilizer annually applied since 1889 to all the plats consisted in each case of eighty pounds of steamed bones and of twenty-seven pounds of muriate of ammonia, or six hundred pounds of bones and two hundred pounds of muriate of potash per acre.

1890. — A grass mixture was sown broadcast on plats 20 and 21. The remaining plats were sown in drills two feet apart, sixteen rows in each plat. The crops seeded in were cultivated two or three times, and cleaned with hoe during the growing season to remove the weeds and clear the crops from admixtures.

The majority of the plats appeared well at the beginning of the season. The seeds proved, however, subsequently, in several instances, a bad investment for our purposes, the distinct varieties and not mixtures of grass seeds were secured.

Plats 11, 12, Kentucky blue-grass, sown Sept. 24, 1889. The growth looked well at the opening of spring, 1890. Cultivator and hoe were applied in the beginning of the season, and again in June, to remove the weeds. The crop was cut for the first time September 19; it did not head out during the season. The hay weighed two hundred pounds on Plat 11, and two hundred and sixty pounds on Plat 12.

Plats 13, 14, red top (*Agrostis vulgaris*), sown Sept. 24, 1889. The seed proved not well adapted to our purpose. It contained a considerable amount of seeds of herds grass. The crop was cut on both plats July 10, and yielded seven hundred and ten pounds of hay in all. The sod was subsequently ploughed under, and cut up by means of a wheelbarrow. The soil prepared later on was reseeded Sept. 24, 1889.

Plat 15, Bokhara clover (*Melilotus alba*) and esparsette sainfoin (*Onobrychis sativa*). Both were sown May 8, 1889. The Bokhara clover yielded, September 9, two hundred and three pounds of hay; the sainfoin did not head out the first year, — it reached about five inches in height. The crops looked fairly well in the spring of 1890, yet everywhere here and there the effects of winter-killing. They were cut for hay; Bokhara clover yielded two cuts, sainfoin but one. Bokhara clover was cut June 24, yielding two

hundred and five pounds of hay, and again September yielding seventy-five pounds. Sainfoin was cut June and yielded one hundred and twenty-five pounds of the aftergrowth would have furnished a rich pasture for cows.

Plat 16, Rhode Island bent (*Agrostis alba*), sown September 25, 1889. The growth looked promising at the opening of the season, yet turned out later on to contain a considerable admixture of herds grass. The crop was cut July and it yielded three hundred and twenty pounds of hay. The sod was turned under July 15, and cut up with a harrow. The plat, after thorough preparation, was reseeded in September, 1890.

Plat 17, meadow fescue (*Festuca pratensis*), sown September, 1887. Started out vigorously with an unbroken sod; began blooming during the first week of June and was nearly through blooming June 20. It was cut July and measured from three to three and a half feet in height. Two crops were secured, June 24 and September 22. The first cut yielded seven hundred and thirty pounds of hay and the second cut two hundred and fifty-five pounds.

Plat 18, meadow fescue, sown Sept. 22, 1889. The seed proved, to a serious degree, to be a mixture of grass seeds. The crop was cut July 9, and yielded three hundred and ninety pounds of hay. The sod was ploughed under July 15, cut up with a wheel harrow and subsequently, after due preparation, reseeded September 24, 1890.

Plat 19, herds grass (*Phleum pratense*), sown September 1889. Looked well in the spring; began to blossom May 30; was cut July 9. It yielded five hundred and thirty pounds of hay. The second crop was cut September and yielded two hundred and five pounds of hay.

Plat 20, a mixture of herds grass, two and one-half pounds (= 2 quarts), and red top, two and one-half pounds (= 6 quarts), which were sown Sept. 24, 1889. The growth looked fair in the spring; was cut July 9; it yielded three hundred and thirty pounds of hay, first cut. The crop suffered somewhat from a brown fungus. The sod was for this reason ploughed under, and the soil prepared, for

manner as previously described in case of other plats, reseeded during the succeeding September.

At 21, a mixture of meadow fescue, two and one-half bushels (= 4 quarts), and herds grass, two and one-half bushels (= 2 quarts), was sown Sept. 25, 1889. The crop looked well in the spring; it proved in part a failure, on account of the mixed character of the seeds, and of the appearance of a brown fungus upon the plants. The crop yielded three hundred and ninety pounds of hay. The land was ploughed under soon after harvesting the hay, and the land reseeded after a careful preparation of the soil, Sept. 25, 1890.

The plats reseeded during the late autumn have been treated in a like manner, with the same mixture which has been used for several years upon Field B; namely, six hundred pounds of ground steamed bones and two hundred pounds of muriate of potash per acre. Extra precaution has been taken to secure seeds fit for our purpose, which in this section consists in comparing single varieties of grasses with other reputed fodder crops, regarding their nutritive character and their comparative economical value, when raised under otherwise corresponding circumstances upon the same soil in Massachusetts.

Some of the results of the analyses of crops raised upon Field B, during 1889 and 1890, as far as they are not yet published, will be found upon a few subsequent pages.

#### *Meadow Fescue.*

[In full bloom, June 14, 1889. (Field B.)]

	Per Cent.
Moisture at 100° C., . . . . .	5.30
Matter, . . . . .	94.70
	<hr/>
	100.00

#### *Analysis of Dry Matter.*

Ash, . . . . .	8.50
Cellulose, . . . . .	39.65
Fat, . . . . .	1.97
Protein (nitrogenous matter), . . . . .	7.85
Nitrogenous extract matter, . . . . .	42.03
	<hr/>
	100.00

Moisture at 100° C.,	.	.	.	.	.	.	.	.	.
Calcium oxide,	.	.	.	.	.	.	.	.	.
Magnesium oxide,	.	.	.	.	.	.	.	.	.
Ferric oxide, .	.	.	.	.	.	.	.	.	.
Sodium oxide,	.	.	.	.	.	.	.	.	.
Potassium oxide, .	.	.	.	.	.	.	.	.	.
Phosphoric acid, .	.	.	.	.	.	.	.	.	.
Nitrogen, .	.	.	.	.	.	.	.	.	.
Insoluble matter, .	.	.	.	.	.	.	.	.	.
Ash, .	.	.	.	.	.	.	.	.	.
Valuation per ton,	.	.	.	.	.	.	.	.	.

[Collected June 14, 1889; just past blooming. (Field B.)]

### *Fertilizing Constituents of Kentucky Blue-grass.*

	PER CENT	
	Fertilized.	Unfertilized.
Moisture at 100° C, . . . . .	6.780	6.780
Calcium oxide, . . . . .	0.366	0.366
Ferric oxide, . . . . .	0.031	0.031
Sodium oxide, . . . . .	0.067	0.067
Potassium oxide, . . . . .	2.110	2.110
Phosphoric acid, . . . . .	0.414	0.414
Nitrogen, . . . . .	1.810	1.810
Insoluble matter, . . . . .	3.203	3.203
Valuation per ton, . . . . .	\$6 74	\$6 74

*Alsike Clover.*

[Collected June 14, 1889; in full bloom. (Field B.)]

	Per Cent.
ure at 100° C., . . . . .	9.96
atter, . . . . .	90.04
	<hr/>
	100.00

*Analysis of Dry Matter.*

ash, . . . . .	13.06
cellulose, . . . . .	26.11
fat, . . . . .	2.19
protein (nitrogenous matter), . . . . .	16.65
nitrogenous extract matter, . . . . .	41.99
	<hr/>
	100.00

*Fertilizing Constituents of Alsike Clover.*

	Per Cent.
ure at 100° C., . . . . .	9.960
m oxide, . . . . .	1.870
oxide, . . . . .	0.104
n oxide, . . . . .	0.266
ium oxide, . . . . .	3.320
horic acid, . . . . .	0.495
en, . . . . .	2.399
ble matter, . . . . .	1.928
tion per ton, . . . . .	\$11 57

*Medium Clover.*

[Collected July 12, 1889; in full bloom. (Field B.)]

	Per Cent.
ure at 100° C., . . . . .	5.10
atter, . . . . .	94.90
	<hr/>
	100.00

*Analysis of Dry Matter.*

ash, . . . . .	9.06
cellulose, . . . . .	30.76
fat, . . . . .	2.36
protein (nitrogenous matter), . . . . .	15.01
nitrogenous extract matter, . . . . .	42.81
	<hr/>
	100.00

### *Fertilizing Constituents of Medium Clover.*

Moisture at 100° C.,	.	.	.	.	.	.	.
Calcium oxide,	.	.	.	.	.	.	.
Ferric oxide, .	.	.	.	.	.	.	.
Sodium oxide,	.	.	.	.	.	.	.
Potassium oxide, .	.	.	.	.	.	.	.
Phosphoric acid, .	.	.	.	.	.	.	.
Nitrogen, .	.	.	.	.	.	.	.
Insoluble matter, .	.	.	.	.	.	.	.
Valuation per ton,	.	.	.	.	.	.	.

*Sweet Clover (Melilotus alba).*

[Collected Oct. 3, 1889. (Field C.)]

Moisture at 100° C.,	.	.	.	.	.	.	.
Dry matter,	.	.	.	.	.	.	.

### *Analysis of Dry Matter.*

Crude ash,	. . . . .	. . . . .
“ cellulose,	. . . . .	. . . . .
“ fat,	. . . . .	. . . . .
“ protein (nitrogenous matter),	. . . . .	. . . . .
Non-nitrogenous extract matter,	. . . . .	. . . . .

### *Fertilizing Constituents of Sweet Clover.*

Moisture at 100° C.,	.	.	.	.	.	.	.	.
Calcium oxide,	.	.	.	.	.	.	.	.
Magnesium oxide,	.	.	.	.	.	.	.	.
Ferric oxide, .	.	.	.	.	.	.	.	.
Sodium oxide,	.	.	.	.	.	.	.	.
Potassium oxide, .	.	.	.	.	.	.	.	.
Phosphoric acid, .	.	.	.	.	.	.	.	.
Nitrogen, .	.	.	.	.	.	.	.	.
Insoluble matter, .	.	.	.	.	.	.	.	.
Valuation per ton,.	.	.	.	.	.	.	.	.

*Sainfoin (Onobrychis sativa).*

[Past blooming; collected June 20, 1890.]

Moisture at 100° C.,	.	.	.	.	.	.	.
Dry matter,	.	.	.	.	.	.	.

*Analysis of Dry Matter.*

	Per Cent.
ash, . . . . .	8.54
cellulose, . . . . .	26.95
fat, . . . . .	4.49
protein (nitrogenous matter), . . . . .	17.70
nitrogenous extract matter, . . . . .	42.27
	<hr/>
	100.00

*Fertilizing Constituents of Sainfoin.*

	Per Cent.
residue at 100° C., . . . . .	12.17
calcium oxide, . . . . .	1.16
potassium oxide, . . . . .	0.43
silica oxide, . . . . .	0.04
iron oxide, . . . . .	0.54
aluminum oxide, . . . . .	2.02
phosphoric acid, . . . . .	0.76
nitrogen, . . . . .	2.63
soluble matter, . . . . .	0.47
total per ton, . . . . .	\$11 57



FIELD "B" 1890.

11	KENTUCKY BLUE GRASS.
12	KENTUCKY BLUE GRASS.
13	RED TOP.
14	RED TOP.
15	BOKHARA CLOVER. SAINFOIN.
16	RHODE ISLAND BENT.
17	MEADOW FESCUE.
18	MEADOW FESCUE.
19	HERDSGRASS.
20	MIXTURE OF RED TOP AND HERDSGRASS.
21	MIXTURE OF MEADOW FESCUE AND HERDSGRASS.

SCALE, 4 RODS TO INCH.

ALL PLATS WERE FERTILIZED  
WITH 600 POUNDS OF GROUND  
BONE AND 200 POUNDS OF  
MURIATE OF POTASH PER ACRE.

# I. EXPERIMENTS WITH FIELD AND GARDEN CROPS. (FIELDS C AND D.)

## *Field C.*

This field comprises an area 328 feet long and 183 feet wide; it is subdivided into two parts, running from east to west; they are separated by a passage-way three feet wide. The system of manuring and of cultivating is the same on both divisions. They are annually manured with a mixture consisting of fine-ground steamed bone, six hundred pounds, muriate of potash, two hundred pounds, per acre. The land is usually ploughed in the fall and early in spring, with the exception of small areas occupied by perennial plants. Fertilizer is applied broadcast early in spring, and subsequently slightly harrowed in.

The crops are in the majority of cases planted in drills, to secure chances for clean cultivation. The land has served, for several years past, for the same purposes; namely, to ascertain the particular degree of adaptation of reputed farm crops to our climate and our soil. In some instances sufficient quantities of one or the other were raised to furnish material for summer and winter feeding experiments. In the majority of cases, however, the main object of the planting was to secure suitable material for analysis, to determine the relative economical value either for general farm purposes or for special industrial purposes. The variety of crops already tested in this connection is quite numerous; for details regarding previous years, we have to refer to our preceding annual reports. Some analyses of crops raised in fields C and D during the year 1889 are published, for the first time, within a few subsequent pages.

*Lotus villosus*.

Yucca (*Hedysarum coronaria*).

Leosinte.

Japanese buckwheat.

Small pea (*Lathyrus sativus*).

Carrot (*Daucus carota*).

1890.—The entire field, both divisions, was ploughed during the autumn of 1889, and again May 1, 1890. The

fertilizer, six hundred pounds of fine-ground bones and two hundred pounds of muriate of potash, per acre, was sown soon after the ploughing, slightly harrowed under, and the various seeds subsequently planted as stated below.

The entire south side of Field C was planted with barley, in rows two feet apart. The north side was occupied by a series of crops in the following order, beginning at the east end of the field : —

- 5 rows English rye grass, rows two feet apart.
- 3 rows early Southern white corn, rows three feet three inches apart.
- 2 rows early Southern cow-pea, rows three feet three inches apart.
- 4 rows horse bean, rows three feet three inches apart.
- 4 rows white soja bean, rows three feet three inches apart.
- 4 rows black soja bean, rows three feet three inches apart.
- 2 rows bush peas, rows three feet three inches apart.
- 4 rows Scotch tares, rows three feet three inches apart.
- 4 rows common vetch, rows three feet three inches apart.
- 4 rows white lupine, rows three feet three inches apart.
- 4 rows serradella, rows three feet three inches apart.
- 4 rows Bokhara clover, rows three feet three inches apart.
- 4 rows sainfoin, rows three feet three inches apart.
- 4 rows English rye grass, rows two feet apart.
- 1 row sulla.
- 1 row festuca No. 1 (Connecticut).
- 2 rows pyrethrum, rows two feet apart.
- 3 rows lotus villosus, rows three feet three inches apart.
- 15 rows Florimond Desprez's richest sugar beet, rows two feet apart.
- 15 rows Bulteau Desprez's richest sugar beet, rows two feet apart.
- 15 rows Dippe's Kleinwanzleben sugar beet, rows two feet apart.
- 15 rows Dippe's Vilmorin sugar beet, rows two feet apart.
- 16 rows Simon Le Grand's white improved sugar beet, rows two feet apart.

The entire field was kept clean from weeds by a timely use of a one-horse cultivator and the hoe.

*Barley.* — The area occupied by barley was 30,504 square feet. It required thirty-four pounds of seed, or forty-eight to fifty pounds per acre. The seed was planted with a brush seeding machine, without plate, May 3. The young plants began to come up May 6. They were cultivated June 3, and headed out June 25. The heads remained free from smut, but the leaves showed many brown spots, due to fungous growth.

The crop reached a height of twenty-five inches, and turned yellow July 25. It was cut July 31, and put in the

on August 3. When threshed, September 15, it yielded 1,000 pounds of grain and 1,795 pounds of straw and chaff, which is equal to 610 pounds of grain and 2,531 pounds of straw and chaff, per acre.

The ground which was used for the production of the rye was ploughed August 2. After being fertilized with 15 pounds of fine-ground steamed bone (one-half of our customary annual dressing of bone), it was planted with turnips and ruta-bagas, in rows two feet apart. The crop was thinned out in the rows and twice cleaned with the cultivator. It was harvested November 5. The turnips came to a good average size, and the ruta-bagas only to a small medium size. Both were of excellent quality for family use, selling in our local market at fifty cents per bushel. The entire crop amounted to 7,715 pounds.

*English Rye Grass (Lolium perenne)*.—This was sown May 30. The young plants appeared above ground June

They made a good growth, yet did not head out during the season. The grass was cut at the customary time for second cut of upland meadow grasses, and the sod left over winter, to notice the effect of that season on the crop. In some of our preceding experiments the plants were winter-killed. The main object of this trial was to secure additional facts regarding that point.

*Early Southern White Corn*.—The corn was planted May 23. The young plants were noticed above ground June

It made a very heavy rank growth, yet proved much too late for maturing in our locality.

*Horse Bean (Vicia faba)*.—This was planted May 23, appeared above ground June 2; reached a height of twenty-five inches before it began to bloom, July 9. It suffered temporarily somewhat from drought; recovered, however, subsequently. The roots of the plants, when thirty-one inches high, July 18, showed a remarkably large number of tubercles. The plant keeps on blooming until a killing frost destroys it. This plant has served us well on former occasions for green manuring.

*Soja Bean (Soja hispida)*.—Two varieties, white and black, were planted May 23; they came above ground June 2. The white variety began to bloom August 9, and

the black variety but one day later. The foliage of the white variety was darker green than that of the black, throughout the season. Both stood the drought well. The roots had apparently no tubercles. The white variety matured sooner than the black one. The soja bean promises to be a valuable addition to the leguminous fodder crops in New England. Two acres have been planted with soja beans during the past season, on the grounds of the station. The growth of one acre has served, in its semi-matured state, as green fodder during the autumn (see summer feeding experiment on previous pages of this report) for milch cows; and that of the other has been put in a silo as an admixture to corn ensilage (see statements on silos).

*Scotch Tares* (a coarse variety of vetch). — The seed was kindly furnished by Mr. James Cheesman of Southborough, Mass., who had imported some for his own experiments. It was planted May 23, was above ground June 3; had reached a height of twelve inches, July 18, before it began to spread. The plants began blooming July 23. The crop was cut for hay August 2. One acre has been planted on another part of our farm during the past season, to serve as winter fodder for cattle.

*Common Vetch* (*Vicia sativa*). — The seed was planted May 23; the young plants were above ground June 1. They began to bloom July 12, when twelve inches high. The plants formed subsequently a rank, thick growth. This variety of vetch has been raised for several years very successfully on our farm, either by itself or as an admixture of oats and barley, for green fodder, toward the close of July, when they begin to bloom. It is one of the earliest annual leguminous fodder crops at our disposal, and has rendered us for several years past excellent services as green fodder for milch cows. It can be used green or in its dried state, as circumstances advise. An admixture of oats and barley renders the crop very acceptable to dairy stock.

*White Lupine* (*Lupinus alba*). — This was planted May 23; appeared above ground June 1; began to blossom July 7, and reached a height of twenty-five inches. The crop became infested with insects, and proved no success during the past season. The best services we have thus far

ed from the various varieties of lupines, white, yellow  
blue, consists in their fitness for green manuring. The  
grows rapidly, is succulent, and comparatively rich in  
enous matter. The crop can be ploughed under with  
in the beginning of August. The disintegration of  
ant has usually sufficiently advanced at the beginning  
ptember to render the soil fit for thorough mechanical  
ration, preparatory to the seeding down of grasses or  
nter crops.

*Serradella* (*Ornithopus sativus*).—The successful cultiva-  
f this valuable fodder crop depends, in our part of the  
ry, apparently in exceptional degrees, on the character  
soil and the season. A deep, sandy loam, and a fair  
ge temperature of the summer season, tend to secure  
ss. Under favorable circumstances we have obtained  
ten to twelve tons of green fodder, with an average  
tage of dry matter of from nineteen to twenty per

Fed green from the beginning to the end of Sep-  
r, 1887 and 1889, at the rate of seventy to eighty  
ss per day, with one-quarter of the ordinary English  
tion (five pounds), the result has been in an excep-  
degree satisfactory. *Serradella* has surpassed in our  
he effect of Southern cow-pea and vetch and oats, as a  
fodder for dairy cows. It competes fairly with soja  
in that connection. Cold and wet summer seasons,  
old, springy lands, each in their own way interfere seri-  
with a timely vigorous growth, and thus with the pro-  
n of a remunerative crop. Our trial with this crop  
g the late season has been a failure, on account of the  
ry character of the land selected for its cultivation.

*Alfalfa Clover* (*Melilotus alba*) and *Sainfoin* (*Ono-  
is sativa*,—*Esparsette*) are already described in previ-  
ages (Field B). The bulky, heavy growth of the  
ara clover, and its pleasant odor, resembling somewhat  
of the sweet vernal grass (*Anthoxanthum odoratum*),  
r it desirable to institute experiments for the purpose  
ertaining its fitness for ensilage. Its stems are succu-  
t the time when the plant has reached its full height  
to four and one-half feet). Our locality is evidently  
old to render the cultivation of sainfoin advisable.

*Sulla* (*Hedysarum coronaria*) and *Lotus villosus* have for several years shown a healthy and vigorous growth on our grounds; they stand our average winter very well. Both deserve a serious trial for stocking pastures with a nutritious growth. They shade the ground more efficiently in such localities than any of our coarser clover varieties. Some subsequent statements of their composition illustrate their high feeding value.

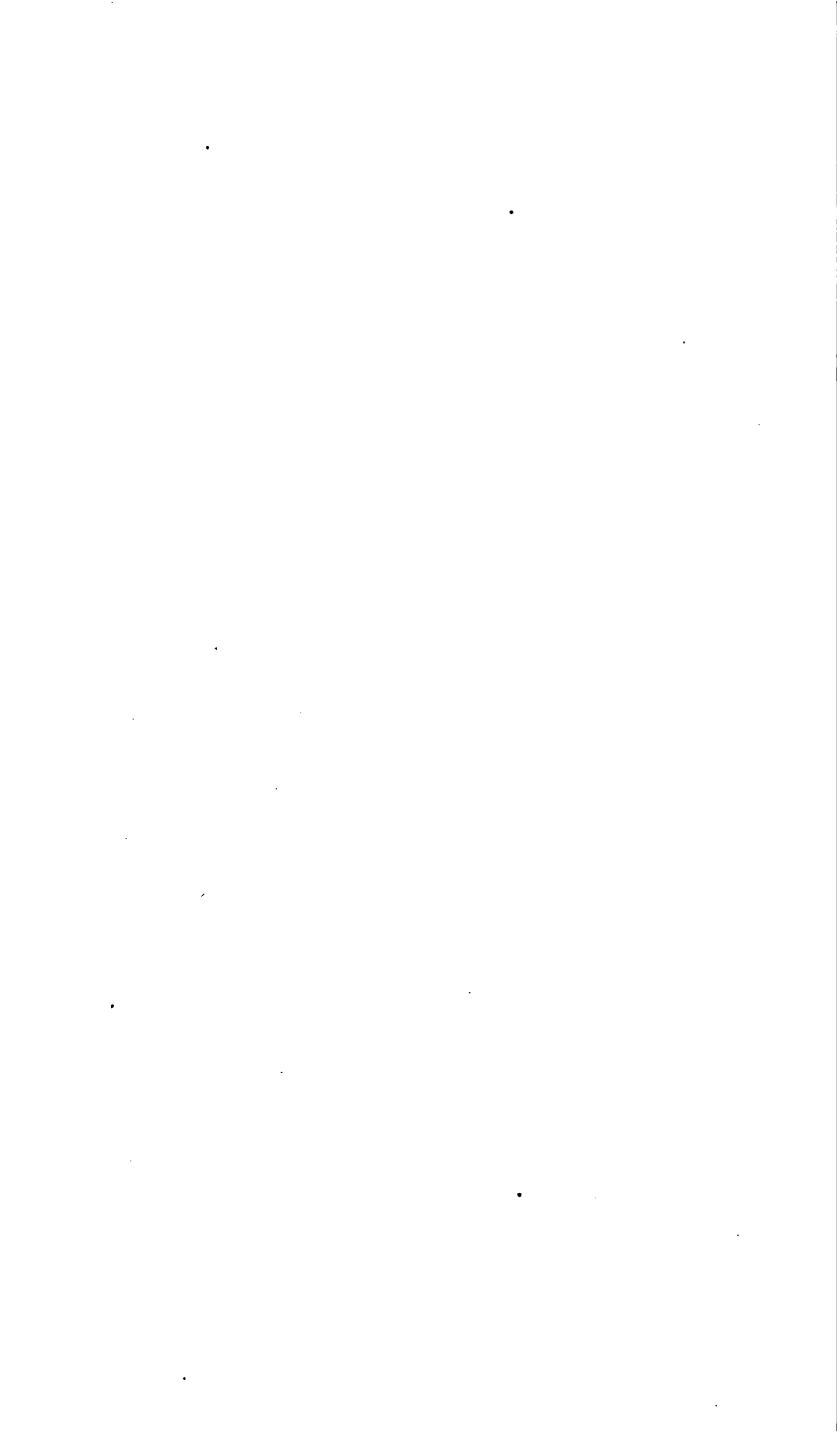
*Sugar Beets.* — The seeds were sent on by the United States Department of Agriculture, for trial, accompanied by the directions to return in due time average specimens of roots of the five varieties for examination at the laboratory of the department in Washington.

They were planted in rows two feet apart, in a well-prepared soil, May 5, each variety properly marked. The young plants came up May 17; they suffered subsequently somewhat from leaf-miners, but soon recovered without any apparent serious consequences. The crop was cleaned twice with the cultivator, and the plants thinned out to six inches apart July 8. They suffered during the latter part of the summer here and there from brown spots on the leaves. The pulling of the roots began October 2, with the following.

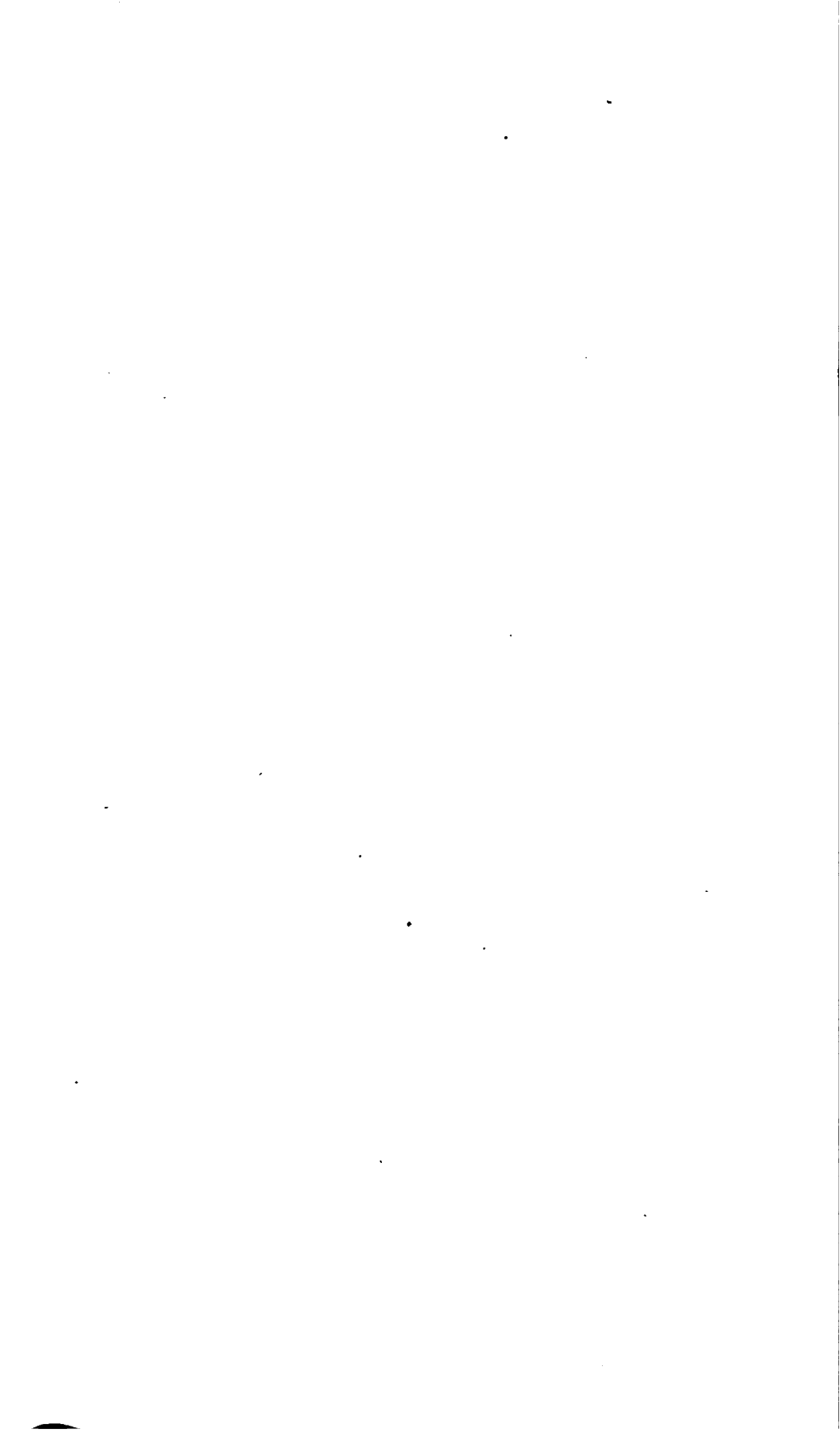
	Pounds.
I. Florimond Desprez's richest, . . . . .	760
II. Bulteau Desprez's richest, . . . . .	760
III. Dippe's Kleinwanzleben, . . . . .	705
IV. Dippe's Vilmorin, . . . . .	680
V. Simon Le Grand's white improved, . . . . .	865
Total, . . . . .	3,770



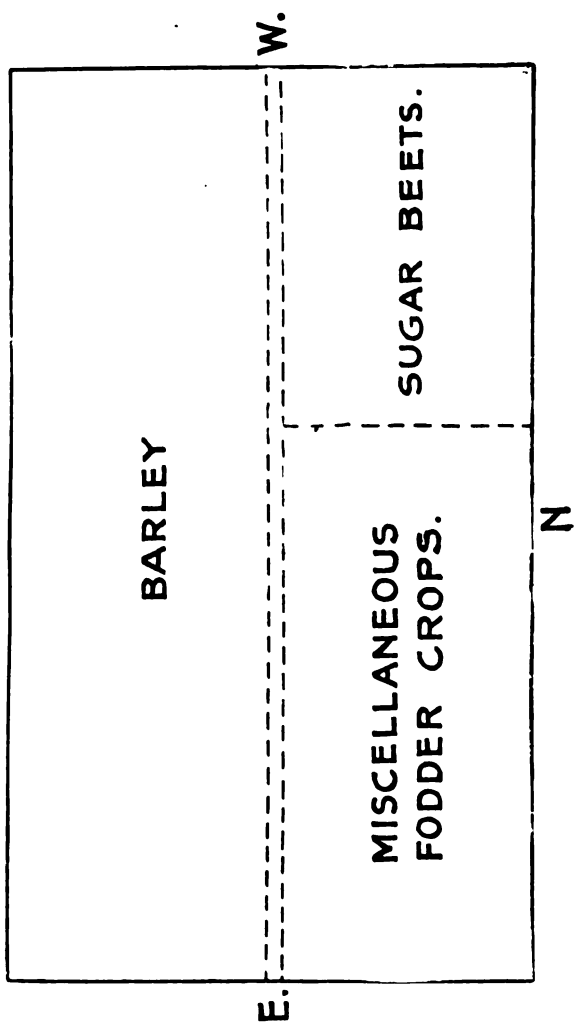








FIELD "C" 1890.



SCALE, 4 RODS TO INCH.

The majority of the roots were of a smaller size than usual. The quality of some varieties proved to be fair; others have but little value for the production of sugar, as will be seen from the analyses farther on.

The importance of a reliable seed, a good preparation of a deep soil, a proper system of fertilization, a close planting, and a subsequent careful mode of cultivation for the successful production of sugar beet roots fit for an economical manufacture of sugar, has been abundantly illustrated by the writer, by a series of field experiments upon the college farm, as far back as 1873-1876. (See Massachusetts Agricultural College reports for those years.)

#### *Field D.*

It comprises an area 328 feet long and 70 feet wide, equal to 22,960 square feet, running from east to west, parallel with Field C, with a grass road twelve feet in width between them. Mode of manuring and preparation of the soil previous to seeding corresponds with that described in connection with Field C. The eastern half of the land was planted with carrots, the western with flax.

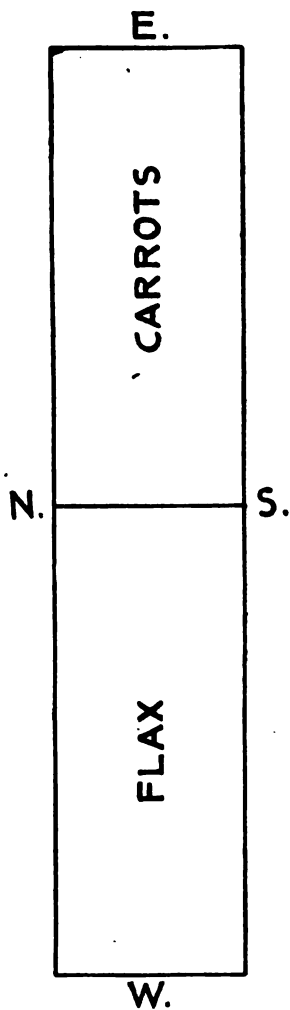
*Flax (Linum usitatissimum).* — About one-fourth of an acre was sown with flax-seed May 23. Forty-four pounds of seed were used for that purpose. The seed was applied broadcast in two directions, to secure a close stand of the crop. The young plants showed themselves above ground May 29. The crop was weeded by hand June 30. It began to bloom July 2, and reached a height of two feet August 1. As soon as the color of the plants changed decidedly into a greenish-yellow tint, they were pulled, to secure a valuable straw. The seeds were but partly matured. The entire crop when harvested weighed 1,510 pounds. The seed heads were taken off by means of an iron comb, and the straw set up out of doors to dry. The dried straw weighed 670 pounds, August 22. This weight corresponds to 2,570 pounds per acre.

The entire crop was sent to a New York company, according to a previous arrangement, to be converted, by a new process of bleaching, etc., into linen goods, to test its quality for that purpose.

*Daucus carota*), *Danvers Yellow*. — The seed  
sown by means of a brush-seeding apparatus, using  
the third in size from the smallest, in rows two feet  
apart, to allow the use of a one-horse cultivator for cleaning,  
July 9. The crop was subsequently thinned out July  
15. They were left for several days in the field in  
order to be covered with the tops of the roots, before hauling.

The yield amounted to somewhat over four tons,  
from sixteen to seventeen tons of carrots per acre.

FIELD "D" 1890.



SCALE, 4 RODS TO 1 INCH.

*Sugar Beets.*

[From station grounds.]

1. Florimond Desprez's richest sugar beet.
2. Bulteau Desprez's richest sugar beet.
3. Dippe's Kleinwanzleben.
4. Dippe's Vilmorin.
5. Simon Le Grand's white improved.

	Date of Test.	Sugar by Polariscope.	Sugar by Fehling's Test.	Degrees Brix.	Specific Gravity of Juice.	Moisture at 100° C.
		Per Cent.	Per Cent.			
beet,	October 29,	11.92	11.95	—	—	82.13
beet,	October 30,	11.66	11.55	—	—	83.19
beet,	October 29,	12.25	12.09	—	—	81.63
beet,	October 30,	11.76	11.69	—	—	83.15
beet,	October 31,	9.74	9.52	—	—	85.04
		Sugar in Juice.	Sugar in Beets.			
		Per Cent.	Per Cent.	Juice.	Juice.	
beet,	November 10,	13.08	—	16.50	1.06783	—
beet,	November 11,	13.16	12.42	17.04	1.07002	—
beet,	November 10,	14.30	13.10	17.30	1.07133	—
beet,	November 10,	12.75	12.26	15.70	1.06436	—
beet,	November 11,	13.42	12.67	16.60	1.06827	—

*Lotus Villosus.*

[Collected June 21, 1889; in full bloom. (Field D.)]

at 100° C.,	10.68
r, . . . . .	89.32
	100.00

*Analysis of Dry Matter.*

ose, . . . . .	8.23
ulose, . . . . .	24.48
. . . . .	3.00
ein (nitrogenous matter), . . . . .	13.49
ogenous extract matter, . . . . .	50.80
	100.00

*Fertilizing Constituents of Lotus Villosus.*

at 100° C.,	10.680
xide, . . . . .	1.579
n oxide, . . . . .	0.336
de, . . . . .	0.076



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## *Fertilizing Constituents of Lotus Villosus* — Concluded.

	Per Cent.
Sodium oxide, . . . . .	0.365
Potassium oxide, . . . . .	2.064
Phosphoric acid, . . . . .	0.688
Nitrogen, . . . . .	1.930
Insoluble matter, . . . . .	0.888
Valuation per ton, . . . . .	\$9 13

## *Sulla (Hedysarum coronaria).*

[Collected June 11, 1889; in full bloom. (Field D.)]

	Per Cent.
Moisture at 100° C., . . . . .	8.32
Dry matter, . . . . .	91.68
	100.00

### *Analysis of Dry Matter.*

Crude ash, . . . . .	9.87
“ cellulose, . . . . .	28.95
“ fat, . . . . .	2.39
“ protein (nitrogenous matter), . . . . .	16.90
Non-nitrogenous extract matter, . . . . .	41.89
	100.00

## *Fertilizing Constituents of Sulla.*

	Per Cent.
Moisture at 100° C., . . . . .	8.320
Calcium oxide, . . . . .	2.203
Magnesium oxide, . . . . .	0.321
Ferric oxide, . . . . .	0.081
Sodium oxide, . . . . .	0.083
Potassium oxide, . . . . .	2.314
Phosphoric acid, . . . . .	0.482
Nitrogen, . . . . .	2.479
Insoluble matter, . . . . .	0.240
Valuation per ton, . . . . .	\$10 98

## *Teosinte.*

[Station, 1889. (Field D.)]

	Per Cent.
Moisture at 100° C., . . . . .	6.06
Dry matter, . . . . .	93.94
	100.00

### *Analysis of Dry Matter.*

Crude ash, . . . . .	6.95
“ cellulose, . . . . .	28.88
“ fat, . . . . .	1.28
“ protein (nitrogenous matter), . . . . .	9.71
Non-nitrogenous extract matter, . . . . .	53.18
	100.00

*Fertilizing Constituents of Teosinte.*

	Per Cent.
at 100° C., . . . . .	6.060
oxide, . . . . .	1.597
um oxide, . . . . .	0.458
ide, . . . . .	0.021
oxide, . . . . .	0.109
n oxide, . . . . .	3.696
ic acid, . . . . .	0.546
. . . . .	1.460
matter, . . . . .	0.315
a per ton, . . . . .	\$8 76

*Japanese Buckwheat.*

[Collected June 28, 1889; little past blooming. (Field D.)]

	Per Cent.
at 100° C., . . . . .	5.72
er, . . . . .	94.28
	<hr/> 100.00

*Analysis of Dry Matter.*

l, . . . . .	12.36
lulose, . . . . .	36.02
, . . . . .	2.22
rotein (nitrogenous matter), . . . . .	10.80
ogenous extract matter, . . . . .	38.60
	<hr/> 100.00

*Fertilizing Constituents of Japanese Buckwheat.*

	Per Cent.
at 100° C., . . . . .	5.720
oxide, . . . . .	3.418
um oxide, . . . . .	0.421
ide, . . . . .	0.148
oxide, . . . . .	0.349
n oxide, . . . . .	3.320
ic acid, . . . . .	0.850
. . . . .	1.629
matter, . . . . .	0.378
per ton, . . . . .	\$9 38

*Small Pea (Lathyrus sativus).*

[Collected Sept. 3, 1889. (Field D.)]

	Per Cent.
at 100° C., . . . . .	5.80
er, . . . . .	94.20
	<hr/> 100.00

*Analysis of Dry Matter*

	Per Cent.
Crude ash, . . . . .	6.30
“ cellulose, . . . . .	32.88
“ fat, . . . . .	1.49
“ protein (nitrogenous matter), . . . . .	16.57
Non-nitrogenous extract matter, . . . . .	42.76
	<hr/> 100.00

*Fertilizing Constituents of Small Pea.*

	Per Cent.
Moisture at 100° C., . . . . .	5.800
Calcium oxide, . . . . .	1.373
Magnesium oxide, . . . . .	0.276
Ferric oxide, . . . . .	0.138
Sodium oxide, . . . . .	0.469
Potassium oxide, . . . . .	1.990
Phosphoric acid, . . . . .	0.592
Nitrogen, . . . . .	2.497
Insoluble matter, . . . . .	1.081
Valuation per ton, . . . . .	\$10.89

*Scotch Tares.*

[Whole plant, at end of blooming; station, 1890. (Field C.)]

	Per Cent.
Moisture at 100° C., . . . . .	15.80
Dry matter, . . . . .	84.20
	<hr/> 100.00

*Analysis of Dry Matter.*

Crude ash, . . . . .	13.76
“ cellulose, . . . . .	30.89
“ fat, . . . . .	1.89
“ protein (nitrogenous matter), . . . . .	22.00
Non-nitrogenous extract matter, . . . . .	31.46
	<hr/> 100.00

*Fertilizing Constituents of Scotch Tares.*

	Per Cent.
Moisture at 100° C., . . . . .	15.800
Calcium oxide, . . . . .	1.698
Magnesium oxide, . . . . .	0.354
Ferric oxide, . . . . .	0.460
Sodium oxide, . . . . .	0.238
Potassium oxide, . . . . .	3.004
Phosphoric acid, . . . . .	0.815
Nitrogen, . . . . .	2.964
Insoluble matter, . . . . .	4.062
Valuation per ton, . . . . .	\$13.61

*Carrots.*

[Station, 1889.]

	Per Cent.
Dry matter at 100° C., . . . . .	89.57
Water, . . . . .	10.43
	<hr/> 100.00

*Analysis of Dry Matter.*

Ash, . . . . .	8.76
Cellulose, . . . . .	8.16
Fat, . . . . .	1.86
Protein (nitrogenous matter), . . . . .	9.18
Nitrogenous extract matter, . . . . .	72.13
	<hr/> 100.00

*Fertilizing Constituents of Carrots.*

	Per Cent.
Dry matter at 100° C., . . . . .	89.570
Carbon oxide, . . . . .	0.064
Silicium oxide, . . . . .	0.025
Hydrogen oxide, . . . . .	0.007
Nitrogen oxide, . . . . .	0.013
Calcium oxide, . . . . .	0.472
Chloric acid, . . . . .	0.086
Phosphorus, . . . . .	0.153
Water, . . . . .	0.027
Total on per ton, . . . . .	\$1 02

*Carrot Tops (1889).*

	Per Cent.
Dry matter at 100° C., . . . . .	9.760
Carbon oxide, . . . . .	2.089
Silicium oxide, . . . . .	0.667
Hydrogen oxide, . . . . .	0.118
Nitrogen oxide, . . . . .	4.028
Calcium oxide, . . . . .	4.883
Chloric acid, . . . . .	0.612
Phosphorus, . . . . .	3.130
Water, . . . . .	0.098
Total on per ton, . . . . .	\$15 52

*Parsnips.*

[Sent on from Amherst, Mass.]

	Per Cent.
Dry matter at 100° C., . . . . .	80.34
Water, . . . . .	19.66
	<hr/> 100.00

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## *Analysis of Dry Matter.*

	Per Cent.
Crude ash, . . . . .	7.43
“ cellulose, . . . . .	7.67
“ fat, . . . . .	3.37
“ protein (nitrogenous matter), . . . . .	6.88
Non-nitrogenous extract matter, . . . . .	74.65
	<hr/> 100.00

## *Fertilizing Constituents of Parsnips.*

	Per Cent.
Moisture at 100° C., . . . . .	80.340
Calcium oxide, . . . . .	0.088
Magnesium oxide, . . . . .	0.045
Ferric oxide, . . . . .	0.005
Sodium oxide, . . . . .	0.006
Potassium oxide, . . . . .	0.617
Phosphoric acid, . . . . .	0.187
Nitrogen, . . . . .	0.217
Insoluble matter, . . . . .	0.019
Valuation per ton, . . . . .	\$1 50

## *Barley Straw.*

[Station, 1890. (Field C.)]

	Per Cent.
Moisture at 100° C., . . . . .	11.44
Dry matter, . . . . .	88.56
	<hr/> 100.00

## *Analysis of Dry Matter.*

Crude ash, . . . . .	5.30
“ cellulose, . . . . .	33.85
“ fat, . . . . .	3.38
“ protein (nitrogenous matter), . . . . .	9.24
Non-nitrogenous extract matter, . . . . .	48.23
	<hr/> 100.00

## *Fertilizing Constituents of Barley Straw.*

	Per Cent.
Moisture at 100° C., . . . . .	11.44
Calcium oxide, . . . . .	0.57
Magnesium oxide, . . . . .	0.18
Sodium oxide, . . . . .	0.18
Potassium oxide, . . . . .	2.09
Phosphoric acid, . . . . .	0.30
Nitrogen, . . . . .	1.31
Insoluble matter, . . . . .	0.24
Valuation per ton, . . . . .	\$6 59

*Bokhara Clover.*

[Collected June 26, 1890. (Field D.)]

	Per Cent.
ure at 100° C., . . . . .	8.50
matter, . . . . .	91.50
	<hr/> 100.00

*Analysis of Dry Matter.*

e ash, . . . . .	8.41
cellulose, . . . . .	33.05
fat, . . . . .	4.79
protein (nitrogenous matter), . . . . .	14.92
nitrogenous extract matter, . . . . .	38.82
	<hr/> 100.00

*Fertilizing Constituents of Bokhara Clover.*

	Per Cent.
ure at 100° C., . . . . .	8.50
um oxide, . . . . .	1.63
esium oxide, . . . . .	0.32
e oxide, . . . . .	0.02
m oxide, . . . . .	0.15
sium oxide, . . . . .	1.99
phoric acid, . . . . .	0.68
gen, . . . . .	2.18
uble matter, . . . . .	0.10
ation per ton, . . . . .	<hr/> \$9 92

*Soja Bean.*

[Collected Aug. 27, 1890, station; blooming. (Field D.)]

	Per Cent.
ure at 100° C., . . . . .	74.17
matter, . . . . .	25.83
	<hr/> 100.00

*Analysis of Dry Matter.*

e ash, . . . . .	11.05
cellulose, . . . . .	24.73
fat, . . . . .	7.22
protein (nitrogenous matter), . . . . .	13.64
nitrogenous extract matter, . . . . .	43.36
	<hr/> 100.00

*Turnips.*

[Experiment Station, 1890.]

	Per Cent.
ure at 100° C., . . . . .	91.78
matter, . . . . .	8.22
	<hr/> 100.00

*Analysis of Dry Matter.*

	Per Cent
Crude ash, . . . . .	9.54
“ cellulose, . . . . .	12.61
“ fat, . . . . .	2.05
“ protein (nitrogenous matter), . . . . .	9.89
Non-nitrogenous extract matter, . . . . .	65.91
	<hr/> 100.00
Albuminoid nitrogen (in dry matter), . . . . .	1.09
Total nitrogen, . . . . .	1.58

*Fertilizing Constituents of Turnips.*

	Per Cent.
Moisture at 100° C., . . . . .	91.780
Calcium oxide, . . . . .	0.061
Magnesium oxide, . . . . .	0.020
Sodium oxide, . . . . .	0.022
Potassium oxide, . . . . .	0.358
Phosphoric acid, . . . . .	0.092
Nitrogen, . . . . .	0.134
Insoluble matter, . . . . .	0.038
Valuation per ton. . . . .	\$0 87

. EXPERIMENTS TO STUDY THE ECONOMY OF USING  
DIFFERENT COMMERCIAL SOURCES OF PHOSPHORIC  
ACID FOR MANURIAL PURPOSES IN FARM PRACTICE.  
(FIELD F.)

The field selected for this purpose was 300 feet long and 7 feet wide, running on a level from east to west. Previous to 1887 it was used as a meadow, which was well worn out at that time, yielding but a scanty crop of English hay. During the autumn of 1887 the sod was turned over, and left in that state over winter. It was decided to prepare the field for special experiments with phosphoric acid by a systematic exhaustion of its inherent resources of plant food. For this reason no manurial matter of any description was applied during the years 1887, 1888 and 1889. The soil, a fair sandy loam, was carefully prepared every year by ploughing during the fall and in the spring, to improve its mechanical condition to the full extent of existing circumstances. During the same period a crop was raised every year. These crops were selected, as far as practicable, with a view to exhaust the supply of phosphoric acid in particular. Corn, Hungarian grass and leguminous crops (cow-pea, vetch and serradella), followed each other in the order stated.

1890. — The land had been ploughed during the preceding year, and again April 19, 1890. The field was subdivided subsequently into five plats of definite size, each running from east to west. These plats were separated from each other by a space eight feet wide.

The plats and spaces between them were ploughed and harrowed alike. The plats were fertilized at stated times; the spaces which separated them received at no time any kind of manurial matter.

The manurial material applied to each of these five plats contained, in every instance, the same form and the same quantity of potassium and of nitrogen, while the phosphoric acid was furnished in each case in the form of a different commercial phosphoric-acid-containing article; namely, phosphatic slag, Mona guano, apatite, South Carolina phosphate



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(floats), and dissolved bone-black. The market cost of each of these articles controlled the quantity applied, for each plat received the same money value, in its particular kind of phosphate.

	Cost per Ton.
Phosphatic slag, . . . . .	\$15 00
Mona guano (West Indies), . . . . .	15 00
Ground apatite (Canada), . . . . .	6 25
South Carolina phosphate (floats), . . . . .	15 00
Dissolved bone-black, . . . . .	25 00

## *Analyses of Phosphates used.*

[I. Phosphatic slag; II. Mona guano; III. Apatite; IV. South Carolina phosphate (floats); V. Dissolved bone-black.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . . . . .	0.47	12.52	0.09	0.39	15.96
Ash, . . . . .	-	75.99	-	-	61.46
Calcium oxide, . . . . .	46.47	37.49	-	46.76	-
Magnesium oxide, . . . . .	5.05	-	-	-	-
Ferric and aluminic oxides, . . . . .	14.35	-	-	5.78	-
Total phosphoric acid, . . . . .	19.04	21.88	36.08	27.57	15.82
Soluble phosphoric acid, . . . . .	-	0.00	-	0.00	12.65
Reverted phosphoric acid, . . . . .	-	7.55	-	4.27	2.52
Insoluble phosphoric acid, . . . . .	-	14.33	-	23.30	0.65
Insoluble matter, . . . . .	4.39	2.45	9.55	9.04	6.26

The following fertilizers were applied to the different plats April 17, 1890: —

Plat I. (south side), 6,494 square feet, . . . . .	{ 127 pounds of ground phosphatic slag. 43 pounds of nitrate of soda. 58 pounds of potash-magnesia sulphate.
Plat II., 6,565 square feet, . . . . .	{ 128 pounds of ground Mona guano. 43½ pounds of nitrate of soda. 59 pounds of potash-magnesia sulphate.

III., 6,636 square feet, .	{	304 pounds of ground apatite.
	{	44 pounds of nitrate of soda.
	{	59 pounds of potash-magnesia sulphate.
IV., 6,707 square feet, .	{	131 pounds of South Carolina phosphate.
	{	44½ pounds of nitrate of soda.
	{	60 pounds of potash-magnesia sulphate.
V., 6,778 square feet, .	{	78 pounds of dissolved bone-black.
	{	45 pounds of nitrate of soda.
	{	61 pounds of potash-magnesia sulphate.

The phosphatic slag, Mona guano and South Carolina apatite were applied at the rate of 850 pounds per acre, apatite at the rate of 2,000 pounds per acre; dissolved bone-black at the rate of 500 pounds per acre. These figures represent approximately the equal local cash values of the different sources of phosphoric acid applied. Nitrate of soda corresponds in all cases to an application of 290 pounds per acre, and the potash-magnesia sulphate at the rate of 290 pounds per acre.

The field was planted with potatoes, Beauty of Hebron; the large-sized ones were cut in halves, and the small ones whole, when planted, May 1, 1890. The rows were three feet three inches apart, and the hills in the rows sixteen inches. Each plat had sixteen rows. The young plants came up quite uniformly; they were cultivated and weeded June 2. Several applications of Paris green with kerosene were made during the season, to prevent damage by Colorado potato bugs. The crop looked well until the middle of July, when the effects of a serious drought showed itself to such an extent that the maturing seemed to be hastened on by it.

The potatoes were harvested from all the plats August 12 and 14. They were assorted in the field into marketable ones and small ones. The former were sold at sixty cents per bushel; the latter were used for chicken feed, at twenty cents per bushel, — our local market prices.

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No. of Plat.	Total Yield of Potatoes (Pounds).	Marketable Potatoes (Pounds)	Small Potatoes (Pounds)
I. (south end), . . .	1,600	1,215	385
II., . . . . .	1,415	915	500
III., . . . . .	1,500	1,070	430
IV., . . . . .	1,830	1,380	450
V. (west end), . . .	2,120	1,590	530

## Yield per Acre.

I. Phosphatic slag, . . .	10,671	8,087	2,584
II. Mona guano, . . .	9,388	6,071	3,317
III. Ground apatite, . . .	9,845	7,023	2,822
IV. South Carolina phosphate, . . .	11,886	8,963	2,923
V. Dissolved bone-black, . . .	13,626	10,218	3,408

## Statement of Percentages.

Plats.	Marketable Potatoes (Per Cent).	Small Potatoes (Per Cent).
I., . . . . .	75.78	24.22
II., . . . . .	64.66	35.34
III., . . . . .	71.32	28.68
IV., . . . . .	75.40	24.60
V., . . . . .	74.91	25.09

## Money Value of Crop.

[One bushel = 60 pounds.]

Plat.	Marketable Potatoes, at 60 Cents per Bushel.	Small Potatoes, at 20 Cents per Bushel.	Total Sum.
I., . . .	134.6 bushels = \$80 76	43.0 bushels = \$8 60	\$89 36
II., . . .	101.2 bushels = 60 72	55.3 bushels = 11 06	71 78
III., . . .	117.1 bushels = 70 26	47.1 bushels = 9 42	79 68
IV., . . .	149.3 bushels = 89 58	48.7 bushels = 9 74	99 32
V., . . .	170.3 bushels = 102 18	56.8 bushels = 11 36	113 54

As a first year's results, the above statements are reported without any further comment, beyond the remark that the success of the season renders the advantages of a soluble form of phosphoric acid very striking. The experiment will be repeated during the coming season. Winter wheat has been sown, to continue the inquiry. One year's results do not furnish a basis for a final decision. The varying accumulation of phosphoric acid in the soil is an important question which deserves a serious consideration as the investigation advances.

Plat I. received 24.18 pounds of phosphoric acid.  
 Plat II. received 28.01 pounds of phosphoric acid.  
 Plat III. received 109.68 pounds of phosphoric acid.  
 Plat IV. received 36.12 pounds of phosphoric acid.  
 Plat V. received 12.34 pounds of phosphoric acid.

The largest yield of potatoes has only removed 3.392 pounds of phosphoric acid from the soil.

*Tabular Statement of the Approximate Amount of Nitrogen, Phosphoric Acid and Potash in the Crop raised.*

PLATS.	Pounds of Potatoes per Plat.	Pounds of Nitrogen in Tubers.	Pounds of Phosphoric Acid in Tubers.	Pounds of Potassium Oxide in Tubers.
. . . . .	1,600	5.440	2.560	9.280
. . . . .	1,415	4.811	2.364	8.207
. . . . .	1,500	5.100	2.400	8.700
. . . . .	1,830	6.222	2.928	10.614
. . . . .	2,120	7.208	3.392	12.296

The calculation is based on E. Wolff's average analyses, 100 pounds of potatoes containing: nitrogen, 3.4 pounds; phosphoric acid, 1.6 pounds; and potassium oxide, 5.8 pounds.

**X. EXPERIMENTS WITH GRASS LAND, EAST FIELD MEADOW.**

The field assigned for a permanent production of grasses covers an area of from nine to ten acres. The main part of the land is nearly on a level, running from south to north, with a slight descent towards the north. The western side of the field is bordered by a public highway, the eastern by the new orchard of the station. Along the eastern side the grounds are gently sloping towards the centre of the field, and are here and there somewhat springy. The location of the level portion of the field renders it liable to a temporary overflow of water from the hillsides toward the south.

The soil consists largely of a sandy loam of from two to three feet in thickness, here and there resting upon either a layer of hard-pan or of a coarse, gravelly material.

The springy character of the eastern slope, as well as the periodical overflow of water from the hillsides toward the southern end of the field, without any adequate outlet to regulate the supply of water from both sources, had rendered the larger portion of the field an unsightly swamp meadow, covered with a comparatively worthless vegetation, previous to 1887.

The general character of the surface soil, as well as the apparent chances of regulating its state of moisture, promised to make the field, under proper management, in an exceptional degree fit for a permanent meadow.

The first attempt at improvement in that direction was made in August, 1886, soon after the first cut of its growth was harvested. The entire work required to secure satisfactory results was carried out during two succeeding summer seasons, on account of limited financial resources.

After securing the outlet necessary for the accumulating water, through the adjoining lands at the western termination of the field, it was decided to run, from ten to twelve feet apart, two parallel ditches from north to south, through the lowest part of the land. One was dug from three and one-half to four feet below the surface of the ground, to serve as a main ditch for laying drain tiles six inches in diameter, to prevent an accumulation and subsequent stagnation of water

upper soil. The other was an open ditch, on an of from one foot to eighteen inches deep, to assist edy discharge of surface water, due to heavy rains or ting of the snow and ice on adjoining hillsides in the

In both instances the necessary fall was secured to of the surplus water in a desirable degree. One ditch sufficed for the whole area; while numerous ditches, starting out from the main tile ditch at distances from each other, were built at all places local conditions indicated an exceptional state of e. The tiles in the branch drain ditches varied from our inches in diameter. The main tile drain at its a starting point runs into a stone drain ten by twenty hich serves as a filter for the turbid water coming e adjoining hillsides in case of heavy rains before y the tile drain. The surface ditch runs up to the drain to prevent an accumulation of water, and reduces the chances of untimely overflow of the

on as the drain tiles were covered and the ditches as practicable levelled, the entire area was ploughed, and in depressions filled up with stones and earth, or s circumstances advised, and left in that condition nter.

ucceeding spring a wheel harrow was used to break rotten sod. The soil was subsequently repeatedly d and harrowed, until it showed the desirable me- d condition required for a successful cultivation of grain crops.

y and oats were chosen as the first crops in case of dow north of the new roadway. Both were seeded in with rows two feet apart, to permit a thorough de- n of an objectionable foul growth, by a frequent use cultivator and hoe.

on as these crops were harvested, one ton of wood er acre was ploughed in, to assist in the disintegration xcess of organic peaty matter, and to serve as a gen- tilizer. Ploughing once more and smoothing the by means of a brush harrow, the entire area was down into grass to serve as meadow. The latter was

subsequently cut into two, by a road built for communication to more remote fields. This arrangement caused a division into a northern and southern meadow.

In case of the land south of the roadway, leguminous plants, as soja bean, Southern cow-pea and serradella, served as first crop. The system of drainage and of seeding down remained the same as before. The meadow north of the road covers an area of somewhat more than six acres, and that south of the road is about three acres in size. The meadow north of the road was sown for the first time in the fall of 1887, with grass, and the one south of the roadway in the fall of 1888.

The more elevated portions of both were seeded down with the following mixture of grass seeds, at the rate of from two to two and one-half bushels per acre : —

- Two bushels herds grass (*Phleum pratense*).
- Two bushels red top (*Agrostis vulgaris*).
- Two bushels Kentucky blue-grass (*Poa pratensis*).
- Two bushels meadow fescue (*Festuca pratensis*).
- Seven pounds sweet-scented vernal grass (*Anthoxanthum odoratum*).

Early in the succeeding spring a mixture of equal weights of medium red clover and alsike clover was added broadcast, at the rate of from five to six pounds per acre.

The lower and still more wet portion of the meadow was seeded down with the following mixture of grass seeds : —

- Twenty pounds of soft brome grass (*Bromus mollis*).
- Twelve pounds herds grass (*Phleum pratense*).
- Nine pounds red fescue (*Festuca rubra*).
- Eight pounds fowl meadow grass (*Poa serotina*).
- Seven pounds Rhode Island bent (*Agrostis alba*).
- Six pounds orchard grass (*Dactylis glomerata*).
- Five pounds crested dog-tail (*Cynosurus cristatus*).
- Four pounds meadow soft grass (*Holcus lanatus*).
- Two pounds sweet-scented vernal grass (*Anthoxanthum odoratum*).

From four to five pounds of alsike clover per acre were added by broadcast seeding early in the succeeding spring (1889).

The seed came up well, and suffered but here and there in wet spots during the first winter. Barren spots were reseeded.

meadows were cut but once during the first summer somewhat later than usual; the majority of grasses as might be expected, head out.

On as the first crop of hay was secured, a system of top-dressing was planned, which would illustrate the comparative effect of top-dressing, as follows:—

Barn-yard manure.

Ground bones and muriate of potash.

Leached wood ashes.

Northern meadow, consisting of six and one-half acres, was subdivided into three plats, I., II., III., running from east to west, leaving a space of twenty feet in between them without any manurial matter.

Southern meadow was divided into two plats, IV., V. (and VI.). Plats I., II., III. were sown down in grass in September, 1887, and plats IV. and V. during September, 1888. The subsequent stated system of manuring was followed in the autumn of 1888, on all plats at the same time.

Plat I. (north end of the field) is equal to 1.92 acres. It was top-dressed during the fall and early spring with barn-yard manure, at the rate of eighteen tons per acre (1889).

Plat II. covers a similar area as Plat I. (83,640 square feet) and received at the same time a top-dressing of barn-yard manure, at the rate of eight tons per acre (1888). The largest part of the barn-yard manure was subsequently removed from both plats before the growing grass interfered with the top-dressing being raked off.

Plat III., about 2.41 acres, received, May 3, 1889, a top-dressing of six hundred pounds of fine-ground steamed bone and two hundred pounds of muriate of potash per acre.

Plat V. (south of roadway), an area of 2.11 acres, received the same dressing, in the same proportion and at the same rate (six hundred pounds ground bone and two hundred pounds muriate of potash) per acre, as Plat III.

Plat VI., equal to .91 acres, received as top-dressing, April 1, 1889, one ton of unleached Canada wood ashes, from the market (1889).



*Yield of Hay in Case of Plats I., II. and III. (Second Year after Seeding), and of Plats IV. and V. (First Year after Seeding).*

PLAT I.	First Cut.	Second Cut.
1.92 acres, . .	10,500 pounds, June 24.	4,370 pounds, August 26.

Total yield per acre, 7,745 pounds, or 3.87 tons.

PLAT II.	First Cut.	Second Cut.
1.92 acres, . .	9,130 pounds, June 24.	4,650 pounds, August 26.

Total yield per acre, 7,177 pounds, or 3.59 tons.

PLAT III.	First Cut.	Second Cut.
2.41 acres, . .	12,200 pounds, June 24.	4,950 pounds, August 26.

Total yield per acre, 7,116 pounds, or 3.56 tons.

Plat IV. (2.11 acres) ; Plat V. (.91 acres) : The first year's hay consisted nearly entirely of herds grass, which was almost the only variety which had headed out in June. The yields of both plats were harvested together.

First Cut.	Second Cut.	Total Yield per Acre.
8,130 pounds, June 24.	3,105 pounds, August 31.	3,720 pounds, or 1.86 tons.

1890. — The different plats were prepared in a similar manner for the season of 1890 as they had been for the preceding season, 1889.

Plats I. and II. received a top-dressing of barn-yard manure during the months of October and November; the former

ate of fourteen tons per acre, and the latter at the eleven tons.

III. was treated in April, 1890, as before, with a of six hundred pounds of fine-ground bones and dred pounds of muriate of potash.

IV. and V. were merged into one plat, and received pressing of unleached wood ashes, at the rate of one acre, April 19, 1890.

on spots in this plat, it being the second year after down, were reseeded by the same seed mixture had been used before.

entire meadow received an addition of from two to pounds of alsike clover seed, broadcast, per acre.

plats were cut as far as practicable at the same time.

*Yield of Hay in 1890.*

PLAT I.	First Cut.	Second Cut.
es, . . .	14,625 pounds, July 1.	3,790 pounds, Sept. 1.

Total yield of hay, 18,415 pounds.

Yield per acre, 9,591 pounds, or 4.80 tons.

PLAT II.	First Cut.	Second Cut.
es, . . .	12,480 pounds, July 1.	3,105 pounds, Sept. 3.

Total yield of hay, 15,585 pounds.

Yield per acre, 8,117 pounds, or 4.06 tons

PLAT III.	First Cut.	Second Cut.
es, . . .	14,460 pounds, June 26.	3,535 pounds, September.

Total yield of hay, 17,995 pounds.

Yield per acre, 7,466 pounds, or 3.73 tons.

*Yield of Hay in 1890 — Concluded.*

PLAT IV. (IV. and V., 1889.)	First Cut.	Second Cut.
3 acres, . . .	13,380 pounds, July 1.	4,080 pounds, Sept. 3.
Total yield of hay, 17,460 pounds.		
Yield per acre, 5,820 pounds, or 2.91 tons		

The total yield of hay on plats I., II. and III. averages 4.19 tons per acre. The total yield on Plat IV. averages 2.91 tons per acre.

The weight of the second cut of hay (rowen) averages about one-fourth of that of the first cut. The dryness of the season during the latter part of July affected seriously the yield of the second cut. The wet season of 1889, as compared with the dry season of 1890, as well as the difference in the age of the two meadows, renders further comparison not advisable at this early stage of our investigation.

## XI. REPORT ON GENERAL FARM WORK.

le from the experimental work described within the  
ing pages, much has been accomplished in other  
ons.

le of this work is of a mere preparatory character, and  
e reported in due time in connection with a detailed  
ption of the experiment with which it is connected.  
mainder concerns merely current farm work, as may  
n from a few subsequent statements.

new orchard, covering an area of from six to seven  
has been in part planted with apple, pear, peach and  
rees; other varieties, as well as small fruits, will be  
d during the coming spring.

eral acres were sown with vetch and oats, soja bean  
orn, to furnish green fodder for the dairy, and to serve  
ilaged crops for winter feed.

silo is filled with fodder corn, and another with half  
ean and half fodder corn.

as been the aim to improve the productiveness of the  
ands, wherever circumstances admitted a free choice of  
le means. To produce a variety of fodder crops has  
he leading object of the general management.

subsequent statement contains an enumeration of the  
pal crops raised in different parts of the farm, on lands  
permanently assigned for the production of fodder for  
e stock of the station, or engaged in a course of prep-  
a for future experiments:—

rst cut), . . . . .	46½ tons.
(second cut), . . . . .	12½ "
corn, . . . . .	5½ "
carrots, 4½ tons; sugar beets, 3 tons), . . . . .	7½ "
tares (dry), . . . . .	1½ "
(grain, 430 pounds; straw, 1,200 pounds), . . . . .	½ "
rain, 1,250 pounds; straw, 2,000 pounds), . . . . .	1½ "
and oats (green), . . . . .	4 "
an (green), . . . . .	10 "
r ensilage, . . . . .	18 "
s, . . . . .	190 bushels.
. . . . .	670 pounds.
aneous fodder crops, . . . . .	1½ tons.

## XII. DEPARTMENT OF VEGETABLE PHYSIOLOGY.

REPORT BY PROF. JAMES ELLIS HUMPHREY.

The past year has seen the department finally settled in the new quarters provided for it, and fairly equipped for work. Owing to repeated delays, the new laboratory was not occupied until the middle of March, and the greenhouse was completed so late that it did not become practically available until fall. Therefore the present contains no reports of greenhouse work. What has been done the past fall consists of preparations for and the beginnings of experiments not yet completed, and is reserved until results can be reported.

The work of the past year here reported upon consists of laboratory and field studies of several diseases which cause very severe losses to farmers and fruit growers, or of the fungi which cause them, as follows :—

1. The black knot of the plum.
2. The mildew of cucumbers, etc.
3. The brown rot of stone fruits.
4. The potato scab.
5. Notes on various diseases.

Reference to the "General Account of the Fungi," in the last report of this station, will be found of assistance to a full comprehension of the following discussions.

THE BLACK KNOT OF THE PLUM.—*Plowrightia morbosa* (Schw.) Sacc.

For a hundred years complaints have come from one or another part of the United States of the destruction of plum and cherry trees through the attacks of a conspicuous and fatal disease, which shows itself in the formation of dark, rough excrescences upon the limbs or even on the trunk of the tree.

These growths increase both in size and in number, spreading from branch to branch and from tree to tree, in a manner strongly suggesting their contagious nature; and

their striking appearance has given to the disease the name by which it is too well known, “the black knot,” or “plum wart.”

The cause of this disease has been the subject of much discussion and of innumerable contributions to agricultural journals, from an early date. Some of the first remarks on the subject are to be found in an article by Prof. W. D. Peck of Cambridge.\* The appearance of the knot is here attributed to the same insect which causes the falling of the fruit, now called the “curculio.” This insect was believed to injure the branch in such a way that, as the writer says, the sap is diverted to the bark, which absorbs it and swells, forming the knots. The general theory here promulgated, that of an *insect* cause, was for over fifty years very tenaciously held and earnestly supported, and indeed is still held by many persons, although wholly discredited by scientific study. The fact that eggs or larvæ of the curculio are very commonly found in the tissue of the knot has been a strong argument with many in support of Peck’s theory; but others, while holding to the general belief in an insect cause, have believed the knots to be due to some species of gall fly (*Cynips*), since none of the beetles, including the curculio, are known to be gall-producing insects. Thus argued the entomologist, B. D. Walsh, in an early paper.† But the difficulty here lies in the fact that no gall fly has been found in or raised from a knot.

Several writers have attributed the trouble to that conveniently indefinite cause,—a diseased condition of the sap; and Dr. Fitch, the former New York State Entomologist, held the disease to be of internal, “constitutional” origin. Quite early, Dr. Joel Burnett of Southborough discussed‡ the question, showed that the curculio merely lays its eggs in the juicy mass of the knot, after it is formed, and attributed its formation to the attacks of a fungus. This is, perhaps, the earliest statement of this

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\* Mass. Agric. Repository, 1819, p. 307.

† Proceedings Entomol. Soc. Philadelphia, Vol. III, p. 613 (1864).

‡ Hovey’s Mag. of Hortic., Vol. IX, p. 281; and N. E. Farmer, 16 Aug., 1843, p. 49.

view in a popular form, although the knots and the accompanying fungus had already been described by the pioneer student of American fungi, de Schweinitz, who appears to have regarded the knots as the combined result of the attacks of a gall fly and the fungus, to which he gave the name *Sphæria morbosa*.<sup>\*</sup> In 1831 he described, in his "*Synopsis Fungorum in America Boreali media digentium*," the destruction of both wild and cultivated varieties by the disease. The distinguished entomologist, Dr. T. W. Harris, in his earlier writings advocated the view that the knot is caused by insects; but later † he mentions the fungus, which, he says, is sure to appear on the knots, and never elsewhere, though he does not commit himself fully to the theory that the disease is of fungous origin. In 1862 the editor of the "Gardener's Monthly," Mr. Thos. Meehan, took strong ground in favor of the fungous origin of the disease, and for several years following a spirited discussion of the subject was carried on by various correspondents in the columns of his journal. At about the same time it was logically argued, in the "Country Gentleman," that, even though insects were found in ninety-nine knots, the finding of the hundredth one free from them would be sufficient to show that they could not be the *cause* of the disease.

Mr. C. F. Austin gave ‡ what appear to have been the first account and illustrations of the microscopic structure of the knot fungus. Entomological writers now began rapidly to accept the fungus theory of the origin of the knots, as is shown by papers from Glover,§ Walsh|| and Riley.¶ Walsh gives at considerable length an account of the supposed structure and life history of the knot fungus, so wholly unlike what we now know of it that it is impossible to conjecture what he could have seen. Up to 1872 knowledge of the fungus was very meagre, and confined to the winter spores to be described later. In that year Prof.

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\* *Synopsis Fungorum Carolinæ superioris*, no. 134 (1821).

† *Insects Injurious to Vegetation*, 2d ed., p. 69 (1852).

‡ *Amer. Agriculturist*, 1863, p. 113.

§ *U. S. Agric. Report*, 1863, p. 572.

|| *Practical Entomologist*, Vol. I, p. 48, and Vol. II, p. 63 (1866-67).

¶ *Gardener's Monthly*, November, 1866, p. 331.

H. Peck, New York State Botanist, gave the first correct account \* of some details of the structure of *Sphaeria* *bosa*, then first describing the summer spores and the time of maturity of the winter spores. In 1875 Dr. Thos. Farlow † gave an illustrated account of the fungus, which was incomplete and incorrect in several particulars, and added nothing to previous knowledge.

Now followed the fullest and best account we have of the structure and life history of this fungus, which was found to be the sole cause of black knot. It was by Dr. G. Farlow ‡ of Harvard University, and remains the authoritative account of the disease and its cause, to-day. The author described the summer and winter spores, and, as will be noticed later, other secondary forms, and figured various organs. This paper has served as the basis of all present, as it must of all work on the black knot; but the comparative inaccessibility renders the repetition of certain descriptions and illustrations not superfluous in connection with the new facts to be presented here. Since its publication, the authority of this paper as to the cause of the disease has remained unquestioned, and all conflicting theories have fallen into discredit among scientific students and observers.

The black knot is known to attack nearly all our wild and cultivated species of plums and cherries; but, so far as the cultivated fruits are concerned, the plums are by far the greater sufferers. It has been thought there must be one or more species of fungi which produce the knots on different host-species. Walsh, for instance, considered that there are two fungi, one attacking the plum and the other the cherry; and a reviewer of his paper suggested a third species of wild plum. Others have based arguments on this opinion chiefly on the fact that certain hosts sometimes suffer from epidemics of the black knot, while others, usually liable to its attacks, remain free.§ De Schweinitz

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\* Paper on Botany, read as a Report before Albany Inst., Feb. 6, 1872.  
† Monthly Micros. Journal, Vol. XIII, p. 118, with two plates; London, March,

‡ Bulletin Bussey Institution, Part V, p. 440, with three plates (1876).  
§ See Gardener's Monthly, November, 1866, p. 335.



has mentioned \* an instance of the sort as having occurred at Bethlehem, Penn. Soon after 1790, the very abundant trees of what he calls "Amarellæ," probably morello cherries, were nearly all destroyed by the knot; while a second visitation, about 1830, swept off most of the plum trees. Many farmers and fruit growers will recall similar cases in their own experience. In spite of these facts, however, there is no evidence that there is more than a single species of knot fungus, which attacks both plums and cherries; and we must probably seek other causes for its occasional selection of particular hosts, to the exclusion of others equally susceptible.

As has been the case with many cultivated plants, certain varieties of plums have been claimed by originators or dealers to be disease-proof. As early as 1843, Messrs. W. R. Prince and Co., nurserymen of Flushing, N. Y., published in the "New England Farmer" a list of varieties claimed by them to be not subject to the black knot, with the remark that they were all varieties of American origin. A few months later, a brief editorial note in the same paper stated, on the authority of prominent growers, that the list was of no value for the vicinity of Boston. And similar claims have usually met a similar fate.

This fungus is strictly American in origin, and has not yet, so far as has been reported, been introduced with its host plants into Europe, as have so many other American fungi. But in the United States it is very widely distributed, ranging from Maine to California, and from Wisconsin to Texas, where it is said to be rare. In most parts of the country it is abundant and destructive.

As above stated, the fungus was first described and named as *Sphæria morbosa* Schw. Various writers have proposed various other generic names as better indicating its relationships, but none of these was generally adopted until Saccardo, regarding it as a member of the family *Dothidaceæ* of the "Black Fungi" (*Pyrenomycetes*), called it *Plowrightia morbosa* (Schw.) Sacc., by which name it is now commonly known.

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\* Synopsis Fungorum Amer. Bor. Proc. Amer. Phil. Soc., Vol. III, p. 269.

The knot may first be observed in the fall as a slight swelling of the branch, arising near an old knot, or independently. If near a knot, it is probably caused by the extension of vegetative threads from the latter; but, if a branch not before attacked, it is probably due to infection by spores from an earlier knot. A section across a young knot shows that the swelling has taken place wholly in the bark and largely in the inner bark (Phloëm), which may be seen radially placed bundles of the fine, intertwined threads of the fungus. The swelling continues through the spring, and the epidermis ruptures, allowing the protrusion of the dark, greenish-brown mass of tissue, presumably due to abnormal growth induced by the irritation caused by the presence of the fungus. This mass is soft and succulent, and its surface is usually irregularly cracked and granular. In May there are developed over the surface numerous short, erect threads, standing rather closely together, like the threads in the "pile" of velvet, giving to the surface a dark-brown, velvety appearance. On these threads are borne, at and near their tips, numerous summer spores of the fungus, obovate bodies of a brownish tint. (Fig. 6.)

Toward midsummer these threads and spores disappear, and, in consequence, the knot loses its velvety appearance and its brownish shade, and becomes dead black in color. It becomes hard and dry, and the larvæ of insects whose eggs were laid in it when it was young and juicy have already begun to destroy its interior, so that very often only the outer crust finally remains. In this fact is to be found the basis of the stoutly defended theories of the exact origin of the knot already alluded to. The surface of the knot may now be seen to be checkered off into little rounded areas, each of which has a slight depression at its centre. In some cases, these black areas do not completely cover the surface, but leave intervening brown spaces. If a section be made across the knot in the fall, near after its first appearance, under each of the black areas described may be seen with the unaided eye a white cavity, which marks the position of a cavity in the dense, black fungus-tissue. This is filled with slender, colorless

threads, as the microscope shows. Later, there appear in these cavities, among the slender threads, club-shaped structures, in each of which are gradually developed eight colorless winter spores, which become ripe and capable of germination by the middle of January. Crozier gives\* a considerably later date for the maturity of the spores in Michigan; but the above, given by Dr. Farlow for eastern Massachusetts, has been found by the writer to be also correct for Amherst. These spores may continue in the cavity for some time, but eventually escape, probably by a pore formed at the central depression before mentioned.

A fully developed knot ordinarily shows no spores remaining by late spring or summer.

Fig. 1 shows a magnified section through three of the spore cavities or *perithecia* of the fungus, containing the club-shaped spore-sacs or *asci*. In Fig. 2 are represented two spore-sacs, with their contained spores, and two of the sterile threads or paraphyses among which they grow.

When obtaining the winter spores in quantity by scraping the freshly cut surface of a section across many perithecia, I have nearly always found mixed with them a small proportion of the globular or slightly elliptical brownish bodies shown at Fig. 4, *a*; but I have not yet met with them in spore cavities.

Studies of the development of the three above-described spore forms have been carried on in the laboratory with interesting results. The following account gives a general outline of the progress and present status of the work. After its completion, a detailed account of the investigations, with their results, both theoretical and practical, will be published, with full illustrations, in a suitable form.

The winter spores, when sown in water and kept in a moist chamber, begin to germinate so promptly that they show germ tubes of some length at the end of one day (Fig. 3, *a*); while in two days as many as three threads, one of which has taken the lead, as a rule, and has become several times as long as the spore, may have developed (Fig. 3, *b*). The principal threads usually originate from

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\* Botanical Gazette, 1885, p. 368.

larger of the two spore cells, though in exceptional one from the smaller cell may take the lead (Fig. 3, The threads may originate from any point on the e of either cell.

e brown spores which occur with the winter spores nate even more promptly than the latter, and may ce in two days threads whose length is ten or fifteen the diameter of the spores (Fig. 4, c).

en sown on nutrient gelatine, prepared with an infu- f prunes, and kept in a moist chamber at the ordinary rature of the laboratory, the winter spores produce ant threads, which grow and branch rapidly, forming e felt, which begins, in four or five days, to show a uscus-brown tint. This color deepens and spreads, here arise on the threads, in six or seven days, small bodies, projecting somewhat above the surface of the ne. These present, when viewed under the micro- , from above, the appearance shown in Fig. 9, from it will be seen that their exterior is composed of a layer of angular cells, interrupted in the middle and st part by an opening or mouth, which is fringed by cle of radiating threads. It may be observed that s escape from the interior of the body through this n in the form of a long, snake-like thread or *cirrhus*, ting of innumerable spores, imbedded in a trans- t, gelatinous substance. If a portion of this thread aced in water, it becomes disintegrated by the rapid ng and solution of its gelatinous basis, thus leaving pores free. These bodies, which are evidently repro- ye organs of the type known as *conidial fruits*, are of an ximately globular form, usually somewhat flattened, with a slightly projecting mouth, as a vertical section 10) shows. The wall is several cells thick, the mem- s of the outer cells being rather thick and dark ed, while those of the inner cells are thin and delicate, a tendency to become gelatinous. It is probable that elatinous substance of the spore *cirrhus* arises, in the nt, as in other cases, by the breaking down of the most cells of the wall of the cavity. The spores are aced (Fig. 10) by budding from the interior cells of

the wall, and, when fully developed, fall from their attachments and become free in the central cavity. These spores correspond in all respects with the brown spores before mentioned as found in small numbers with the winter spores. The latter are undoubtedly developed in special spore cavities, corresponding in structure to those developed on gelatine, which occur sparingly among those producing winter spores (*ascospores*). But I have not yet been able to recognize them in sections of the knot. From the fact stated it becomes probable that this hitherto undescribed fruit form is the *pycnidial* fructification of the black-knot fungus, and it may be seen that it corresponds in general with the known *pycnidia* of related fungi.

The spores, which we may designate *pycnospores*, taken from pycnidia developed on gelatine, germinate in water as promptly and in the same way as those from the knot (Figs. 4 and 5). When sown on fresh nutrient gelatine, their threads develop much more rapidly and branch more freely than in water, as may be seen by a comparison of Figs. 5, *c*, and 5, *d*. On gelatine the spots formed by the masses of dark threads become evident to the unaided eye in eight or nine days, and new pycnidia and pycnospores are produced in from nine to ten days, a slightly longer time than that required for their development from the winter spores. I have not yet succeeded in obtaining perithecia with winter spores from cultures.

Dr. Farlow describes, in his paper, quoted above, four kinds of spore-fruits, as follows: (1) those producing winter spores (*ascospores*) in sacs; (2) those producing bodies which he terms *stylospores*, which form has since been named, by Saccardo,\* *Hendersonula morbosa*; (3) spore-fruits of the type usually known as *spermogonia*; (4) others which he calls *pycnidia*, which differ essentially, however, from the pycnidia above described. Of these forms the third has not been met with in course of my studies, but it is yet too early to say it is not likely to be found. I have seen, in a few sections, small spore-fruits among the perithecia, which may be identical with Dr.

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\* See *Sylloge Fungorum*, Vol. III, p. 445.

's *pycnidia*, above mentioned. They have oblong or oval cavities, lined with layers of small cells, from which are produced large numbers of nearly colorless, spherical spores, about half as long as the pycnospores developed on gelatine. I have not been able to see that they are developed on short threads, as is said by Dr. Farlow in the case with the spores in his pycnidia. Should it be proved to belong to the life cycle of the knot-fungus, it will constitute its second pycnidial stage.

*Hendersonula* or stylosporoc form described by Dr. Farlow, which would constitute a pycnidial form, according to present terminology, has also not been found even to the extent of a single spore, though very careful and thorough search has been made for it. It is also to be noted that, if it were a genuine pycnidial stage of the fungus, it might be produced on cultures, as the pycnidia described have been. This total failure to find the form has led me to give it up as a feature in the developmental history of *Plowrightia morbosa*. On consultation with Dr. Farlow, he has kindly permitted me to say here that he does not think there is sufficient evidence that this is really a stage of the knot-fungus, although it frequently occurs with it.

Summer spores, when sown on prune gelatine, swell to an elliptical form, resembling that of the pycnospores, and terminate by producing threads (Fig. 7). These also form close, felted patches, and assume, after a time, the characteristic dark color before mentioned; and send up, at last, erect threads, which bear conidial spores like those which they have grown (Fig. 8). No other form has developed on these cultures, even after a long time.

While considerable work remains to be done in deciding the connection of doubtful spore forms, and in completing the structural history of this pleomorphic fungus, the most important work now remaining is the investigation of its relations to its host plants. How it attacks them, how the knots begin to develop, and the history of their development, are the subjects which most need investigation.

This Department has not heretofore been prepared for this study, but the necessary preparations have been

made during the past season, and it is hoped that the work of the coming year may shed some light on these questions, which bear so directly and so practically on the treatment and prevention of the disease.

THE CUCUMBER MILDEW. — *Plasmopara Cubensis*  
(B. & C.).

In 1868, Berkeley and Curtis described \* a fungus of the *Downy Mildew* group from specimens on a cucurbitaceous plant from Cuba, under the name *Peronospora Cubensis*. This fungus remained then comparatively unknown for twenty years; but meanwhile Spegazzini † had described a species on a cucurbitaceous host from the Argentine Republic, which he called *Peronospora australis*, and Trelease ‡ found the same species on the one-seeded star cucumber (*Sicyos angulatus*), in Wisconsin.

In 1889 Dr. W. G. Farlow § reported having received from Japan the previous year a fungus on cucumber leaves, and in 1889, from New Jersey, the same fungus on the leaves of hot-bed cucumbers. The same fungus appeared during 1889 on leaves of cucumbers and squashes in various parts of the country, and seemed likely to become a serious pest. The structure of the fungus is quite different from that of the only mildew heretofore known on *Cucurbitaceæ* in the United States, namely, *Peronospora australis* (compare Figs. 11 and 15); but a comparison with original specimens of the little-known *P. Cubensis* has shown it to be undoubtedly that species. Its almost simultaneous discovery in widely separated parts of the earth, where it had previously been wholly unknown, is a remarkable instance of the apparent vagaries of fungous epidemics, and shows how much we have yet to learn of the conditions which govern them.

This fungus attacked with fatal result a plot of cucumbers in Amherst the past season, and was received on

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\* Journal Linnæan Society, Botany, Vol. X, p. 363.

† Annales Sociedad Cientif. Argentina, 1881, XII, p. 81.

‡ Botanical Gazette, 1883, p. 331; see also Paras. Fungi Wisconsin, p. 6.

§ Botanical Gazette, 1889, p. 187.

es from Mr. S. F. Libby of Milford, Mass., who re-  
it as killing the leaves completely, and thus stopping  
rowth of the plant and its fruit. It is unquestionable that  
s and gardeners have here a new and serious hin-  
t to the successful cultivation of squashes and cucum-  
and there is no reason why it should not extend to  
s also. The fungus has never been figured, so far  
n aware, and some facts in regard to its structure are  
cking. It is, therefore, thought worth while to sup-  
me of these deficiencies here, with figures, for com-  
n, of the mildew of the wild star cucumber, which  
also, very possibly, be found on cultivated *Cucurbita*-  
the future.

vegetative threads of *P. Cubensis* and of *P. austra-*  
not differ essentially from those of other downy  
ws, and ramify among the cells of the host plant,  
g into these cells at intervals absorbing organs or  
*ria*, by means of which they abstract nourishment  
them, and weaken or ultimately kill them. Among  
wny mildews we meet two types of these haustoria.  
grape-vine mildew and others, they are small, knob-  
utgrowths from the fungus threads, merely large  
h to reach the interiors of the cells of the host; while  
ers, like the mildews of the turnip and of spinach,  
ned later, they are large and branching, and often  
fill the cells within which they are developed. In  
f the species under discussion the haustoria are of  
st type, as shown in Figs. 14 and 16. The haustoria  
*australis* have been said to grow often large, some-  
filling the cell, but I have observed none such.  
the vegetative threads grow out through the pores  
epidermis of the leaf, chiefly on its under surface, the  
s which bear the summer spores or *conidia*. Those  
*Cubensis* are quite scattered over the yellow and  
ooking spots caused by the development of the  
s in the leaf, and do not form a close felt visible to  
ked eye, as do so many mildews, because it is rare  
ore than two of the conidial threads issue from  
n leaf pore (Fig. 12). *P. australis*, on the  
ry, forms dense white tufts of small extent on the



leaves of the star cucumber, because its conidial threads are developed in large numbers from each of a number of closely situated leaf pores. The structure of the spore-bearing threads in the two species is strikingly different, and furnishes the essential means of distinguishing between them. The details of this structure and the chief differences may best be understood from Figs. 11 and 15. Correlated with the development of small haustoria is frequently found, as in the grape-vine mildew and in *P. australis* (Fig. 15), a pinnate branching of the conidial threads, and conidia with an apical papilla, which germinate by producing zoöspores instead of a tube. In *P. Cubensis* we have the anomaly of conidial threads which follow the type of branching usually seen in the species with branched haustoria, and conidia of a violet tint, such as are almost unknown except among the latter group; while the haustoria are small, and the conidia have the apical papilla, and produce zoöspores on germination. This species goes far to break down the distinctions held by some writers to exist between the two groups which constitute the genera *Plasmopara* and *Peronospora* of recent writers, though all formerly included in *Peronospora*. If the distinction is to be maintained on the basis of the germination of the conidia, we must then call these two fungi *Plasmopara australis* (Speg.) and *Plasmopara Cubensis* (B. & C.). The formation of resting spores has not been observed in either species, yet it is evident that they have some means of surviving the winter. This is equally true of a considerable number of mildews; and the problem of what substitutes for resting spores certain species possess is one of the most interesting and important ones connected with these fungi.

This Department wishes to investigate all diseases affecting cucumbers, squashes and melons, cultivated either in the open air or under glass, and to this end urgently requests all persons who suffer from any disease of these crops to send specimens, with details as full as possible, to the writer, as soon as it appears.

THE BROWN ROT OF STONE FRUITS. — *Monilia fructigena* Pers.

The fact that great and sometimes almost total losses of the crop occur among the stone fruits, the peach, plum and cherry, through the attack of this disease, has been for some time recognized, more generally, perhaps, in this country than in Europe. Its effects have been described at some length by some European writers on plant diseases, while by others it is barely mentioned. So far as its general characters and cause are concerned, it has been pretty fully described by Peck,\* Arthur,† Galloway‡ and Smith,§ and a brief summary will suffice here.

The disease is at first characterized by the browning of the fruit, whose flesh then becomes shrunken and shrivelled and a thin, tough pellicle over the stone, and remains in this condition and resists decay for an indefinite period. The term "mummied" aptly describes fruits which have been thus affected. Soon after it first turns brown, there may be seen thickly scattered over the surface of the fruit the ashy spore tufts of the fungus which has been shown to be the cause of the disease, and is known as *Monilia fructigena* Pers. The vegetative threads of this fungus ramify through the tissues of the fruit and break through the surface, where they produce spores in chains at their ends. When cultivated in the laboratory, these chains often reach a very great length, and branch more freely than is the case out of doors (Figs. 17-19). It may be easily observed on such specimens that the spores are formed by a sort of budding, the terminal one being the newest; and that where branching occurs it originates in a terminal cell, which assumes a somewhat triangular form, and buds from its two outer angles, as shown in Fig. 18. The spores, when fully formed, fall from the chains, and are capable of immediate germination. Under suitable conditions their germ threads can penetrate the uninjured skin of fruits, or

\* Thirty-fourth Report N. Y. State Museum, p. 35 (1881).

† Fourth Report N. Y. Agric. Exp. Station, p. 254 (1885).

‡ Report U. S. Dep't. Agr., 1883, p. 349, and Plates V and VI.

§ Journal of Mycology. Vol. V, p. 123 (1889).

the tissues of flowers or even of leaves and young twigs, killing and browning all the tissues which they penetrate, and rapidly spreading. Finally, these threads come to the surface, and produce a new crop of spores.

Besides the stone fruits, this fungus is known to attack the apple, pear and others; but its destructive effects seem to be chiefly confined to the first named. My attention was called, in July, 1890, to a loss of early peaches, amounting to a very large percentage of the whole crop, in a small orchard of the Massachusetts Agricultural College, just following several days of warm and moist weather. The wholesale rotting then in progress was sufficient proof that the germ threads of the fungus can penetrate the uninjured skin of the peach, a power which has been doubted by some writers, though lately proved in laboratory cultures by Smith; for it is not to be supposed that most of the fruits on a tree were sufficiently injured to admit the entrance of germ threads otherwise unable to penetrate them. The mummied fruits usually remain hanging upon the branches, or lie, without decaying, on the ground beneath, until the following spring, when, as Smith has shown, the fungus threads, which have lain dormant through the winter, begin, under the influence of warmth and moisture, to grow again, and soon the apparently dead and harmless remains are covered with the ashy spore tufts, which will infect the new season's crop.

That the fungus does winter over in the dried flesh of its victims was further shown last April, by placing mummied plums, picked from the branches where they had hung all winter, before the weather was sufficiently warm to have caused any development, in a moist chamber in the laboratory. In two days the plums were thickly covered by the spore tufts of the fungus. A microscopic examination of the dried flesh from such plums just removed from the tree showed the presence of numerous threads, composed of large, thin-walled cells (Fig. 20, *a*), and of single thick-walled cells of somewhat varying form, which are probably to be regarded as the resting vegetative cells, known as *Chlamydothecæ* or *Gemmæ* (Fig. 20, *b*). It is probably these cells especially which are able to withstand

unfavorable conditions of winter, and germinate again under circumstances favor once more. They have been known to be able to retain their vitality for a long time, under certain circumstances, but it would seem that the dryness of a room is fatal in a comparatively short time; for spores of the previous season, picked April 1, and kept till November 1 in a dry pasteboard box, in a closet, failed completely to produce the fungus in a moist chamber, though they had an abundant opportunity to do so. Galloway states that spores of the fungus collected in July, 1886, germinated in January, 1888, but does not state how they were kept meanwhile.

It has often been supposed that *Monilia* represents simply the summer spore form of some fungus whose other stages might be found on other substances. With a view to getting some light on this question, several cultures of the *Monilia* have been made on nutrient gelatine, prepared with an infusion of prunes; and one was continued for four and five months, without, however, producing any other than *Monilia* spores, which appeared in three days after the beginning of the culture. These facts, and the abundant demonstration of the ability of its vegetative threads to survive the winter, apparently through the formation of resting cells or *Gemmae*, point to the probability that, whatever its origin, any other forms once connected with it have been lost, and it is therefore fairly safe to regard it as an anomalous fungus. Other points of theoretical interest have come up during the progress of the cultures, which will be discussed in a technical journal.

Assuming that the *Monilia*, which is classed among the perfect fungi, is an independent form, and that the course of development sketched above constitutes the whole of its life cycle, the problem of avoiding to a great degree the losses now annually caused by it becomes comparatively simple one. While something can probably be done by judicious spraying with fungicides, the solution is largely one of orchard hygiene. If fruit growers could be made to realize the power for harm which is in a few mummied fruits, they would readily understand that the prompt removal of every one which shows a

trace of this disease is the first necessity, and that the expense involved in a frequent inspection of the orchard during the fruiting season, and the thorough removal of all diseased twigs and fruits at the close of the season, would be manyfold repaid in the increased returns. The caution cannot be too often repeated, that all plants or parts of plants attacked by fungi should be burned at once, in order to completely destroy all spores contained in or upon them, and so prevent their becoming a source of infection. Of course, where several orchards lie in the same neighborhood, the owners of all must co-operate, to secure the best results; but if this were done, and all orchards put into a thoroughly healthy condition every fall, the losses from this and some other diseases would hardly be worthy of mention. The pathologist can do no more; and, if the cultivator will persist in the old uncleanly and wasteful way, let him take the consequences, and blame no one else.

#### POTATO SCAB.

Field experiments in continuation of those of 1889, and on lines suggested by the experience of that year, were carried out during the past season under fairly favorable conditions; and the results, though almost wholly negative, are not without practical value.

After the harvesting of the crop in 1889, the plot devoted to potato experiments was ploughed, and its southern half, including sections 1 to 14, was sown with winter rye, in order that it might have, as far as possible, the character of sod land when ploughed in the spring. The rye came up and made good growth before the close of the season. In the spring it was in vigorous growth, and eight inches high when the plot was again ploughed, May 7. The whole plot was dressed with bone and potash, in the same amounts as in the previous years, and this dressing and the green rye were harrowed in.

Seven varieties of potatoes had been obtained in quantity from Mr. G. D. Howe of North Hadley, together with small sample lots of six other varieties. The chief varieties were the Monroe County Prize, Quinipiac, Triumph,

White Seedling, Houlton Rose, Hampden Beauty, and the Rural New Yorker, No. 2; while those of which small samples were received were Howe's Premium, Rough Diamond, Northern Spy, Early Market, Golden Flesh and Potato Red. Retaining the same division into sections as was used last year, each of the principal varieties was planted in drills on four sections, except the Monroe County Prize, which was planted on only three sections, leaving one section, No. 14, for the samples, of each of which half a row was planted. The chief varieties were arranged that two sections of each were on that half of the plot which had been sown to rye, and two on the other half; and so that one row of each was planted somewhat deeper and one considerably deeper than the usual depth of planting. All the varieties grew well and received the same cultivation. In spite of the considerable interval between the maturity of the Triumph, the earliest, and that of the Rural New Yorker, the latest, all were allowed to remain in the ground until the last was matured, and were dug on the 16th and 17th of September. The crop was much better than that of 1889, and markedly less scabby. The results need not be given in full detail, since this would involve unnecessary repetition. It is sufficient to say that they fully warrant, so far as they go, the following statement, which must, however, be given no more weight than that due to a single experiment.

The only variety which showed no scab was the Rough Diamond, which, however, has few other features to recommend it, and seems interesting chiefly as a curiosity.

The best varieties, both in the general character of the crop and in their comparative freedom from scab, were the Rural New Yorker and White Seedling.

The ploughing-in of winter rye produced no perceptible effect on the scabbiness of potatoes raised on that half of the plot, as compared with the other half.

The comparison of results from deep and shallow planting does not bear out the opinion, doubtfully expressed last year, that deep planting diminishes scab. Neither for any single variety nor for the plot as a whole was any

distinct advantage in this respect noticeable for either method of planting.

5. The free use of coal ashes in the drill, which was tried by request, had no observable influence on the development of scab in the present case, although it has been thought by some to favor its development, and others have regarded it as a preventive.

6. The thicker-skinned and red-skinned varieties show no greater resistance to scab than others; our best results this season were from light-skinned and rather delicate, fine-grained sorts. These results conflict with some rather general beliefs, but they are the outcome of experiments carefully planned and carried out, and involve no inherent improbabilities.

The results of extended studies as to the *cause* of potato scab have lately been published by Mr. H. L. Bolley.\* He believes it to be due to the action of a *Bacterium* which lives in the soil, and can live parasitically on the potato tuber, causing an irritation which results in the formation of the scab. Mr. Bolley's experiments were well planned and apparently carefully conducted, and his results are of much value. The scab produced by him was apparently the form first called by the writer in the last report of this station the "surface" form. In Bulletin No. 105 of the Connecticut Agricultural Experiment Station, Dr. Roland Thaxter has announced the results of some investigations, in which he had obtained, from potatoes affected by the "deep" form of scab, a vegetable organism of doubtful relationships, which, when sown on growing potatoes, reproduced the same form of the disease in a striking manner.

In our own microscopic study of scabbed potatoes, bacteria were, of course, constantly met with, and fungus threads occasionally, but never under such circumstances as to raise any serious suspicion of their causal relation to the trouble. Had such a suspicion been raised, however, it would have been impossible to have demonstrated the correctness or falsity of the view, since the Department had then

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\* Agric. Science, September and October, 1890.

the necessary accommodations nor equipment for such investigations. At present other equally important studies progress, and it does not seem advisable for us to take this subject, especially since the bacteriological investigations are of a very special nature, and are best conducted by persons who devote their entire attention to that field. It is hoped, however, that some European bacteriologist will take up the subject, and repeat the investigations recently made in this country; since, as was shown in our report, the same disease prevails there, at least in its "surface" form, as well as here.

From what has been already said, it is evident that the "scab," as commonly used, is a general and not a specific one. The rough crusts which give rise to the name are formations produced by the growing tuber, in response to, and as an attempted protection against, external irritating influences. That this irritation is sometimes due to parasitic or semi-parasitic organisms seems probable, in the light of the investigations mentioned above; but that it is always so produced is by no means proved, since, in practice, badly diseased tubers have too often given a practically smooth crop. One who insists on the presence of a specific organism as a necessary preliminary to the development of scab must admit a very strong dependence on peculiar conditions on the part of such organism.

It is difficult to believe that the "deep" form of the scab is entirely distinct from the "surface" form, as Dr. Thaxter's results would indicate, although he has found potatoes attacked only by the former near New Haven, Conn., in the last season; for both forms have occurred abundantly on potatoes from the same hill on our experimental plots, and not uncommonly both on the same tuber. And the "deep" form has shown, in our experience, such differences in depth as almost to furnish a series running up to the "surface" form; yet it is true that a certain darker and more decayed appearance almost always distinguishes it from the latter.

With regard to the prevention of these troubles, whatever their cause, our recommendation of last year can be repeated with much stronger emphasis. The best land for



potatoes, so far as freedom from scab is concerned, is a light, porous, sandy soil. On such land there may often be raised, year after year, perfectly smooth crops; while on damp, heavy soil, as bad a crop may result the first year as after years of continuous potato culture. At present, then, we can only say that what is termed potato-scab is due to the reaction of one or more of several possible external irritants upon the tubers while they are growing, and that the conditions which least favor its appearance are those afforded by a *light, open, thoroughly drained soil*.

#### NOTES.

**DAMPING OFF.**—During the past fall, a few cucumber seedlings in the Station greenhouse were killed by the affection known as “damping off,” so common and destructive to seedlings in the forcing bench and the hot-bed. The disease, which manifests itself in the decay and consequent falling over of the seedling stem near the level of the surface of the soil, is familiar to most persons who raise plants under glass.

So far as I am aware, the cause of this trouble has not been precisely investigated in this country, though it has been assumed to be caused by the fungus which is known to produce the same effect in Europe, *Pythium de Baryanum* Hesse. The case mentioned afforded an opportunity to ascertain the correctness of this assumption. Examination of the stem of a fallen seedling at the point of attack showed the presence of abundant fungus threads in its disorganized tissues. A piece was placed in a drop of water in a moist chamber, and the threads rapidly extended themselves over the glass slip which held the whole, and in two days had developed the reproductive organs figured in Figs. 21 to 23. These structures agree with those of *P. de Baryanum*, as figured by Hesse, and the fungus is probably the same as that which produces the same results in Europe.

This fungus is closely related to the downy mildews, and reproduces itself by means of zoospores and by resting spores. Fig. 21 shows two zoösporangia, and in Fig. 23 are seen

stages in the production of resting spores. Other bodies (*gemmæ*) may be formed from the threads in a purely vegetative way (Fig. 22).

The very general distribution of this fungus is indicated by the fact that the soil in which the affected seedlings grew in the present case was, as nearly as possible, virgin soil, which had just been brought from a natural woodland, where it had probably been undisturbed for a very long period, and was in a new greenhouse then first used.

It is interesting to find that "damping off" is always caused by the same fungus, certain directions for its treatment may be given.

Plants affected should be at once removed, with the soil immediately surrounding them, and burned. If this is done as soon as the seedling falls, the trouble can be kept in check, since the fungus will be destroyed before its reproductive organs have developed. When a hot-bed propagating bench has become so badly infested by the fungus that a large part of the seedlings or cuttings "damp off," the soil should be entirely removed to a distance, and the remaining walls thoroughly cleaned and washed with lime whitewash, and refilled with fresh earth. After treatment, the prompt removal of diseased plants should be sufficient to limit the trouble to an occasional

**MILDEW OF SPINACH** (*Peronospora effusa* (Grev.)) has caused serious damage to that crop on the grounds of the Massachusetts Agricultural College. This fungus is one of the downy mildews, and makes its presence known by the appearance of discolored blotches on the upper surface of the leaf, and corresponding patches of its matted spore-bearing threads on the lower surface. Since this crop is cultivated for the leaves, the disease can be controlled by picking and destroying the leaves as they become attacked, and by thorough cleaning of the field as soon as the crop is removed.

Spinach belongs to the same family of plants with some common weeds, which are also attacked by this fungus. One of these which appears in almost every field is the so-called pigweed or lamb's quarters (*Chenopodium*). This plant is equally subject to the attack of the

same fungus; and this fact makes it obvious that spinach fields should be kept scrupulously free from pigweed, which, if allowed to grow, may afford a favorable breeding place for the mildew.

THE GRAPE-VINE MILDEW (*Plasmopara viticola* (B. & C.) Berl. & de T.) might be expected to attack also our native species of *Ampelopsis*, the Virginia Creeper, and the species from Japan, now commonly planted under the name of Japanese or Boston ivy, since the species of *Ampelopsis* are so nearly related to the grapes that they are placed by some writers as a subdivision of the genus *Vitis*, which includes the true grapes. Its occurrence on the Virginia Creeper has been reported from various localities; but, so far as I know, the Japanese ivy (*A. Vcitchii*) has been only once reported as its host.\* It is therefore worth while to note the occurrence of the mildew on the latter plant, in October last, in Amherst. The fungus was well developed, almost as luxuriant as on the grape, and its summer spores, always varying considerably in size, showed an unusually wide range of dimension. The leaves attacked were large and strong, and the fungus threads penetrated their tissues very thoroughly, though a careful examination failed to discover the resting spores. The damage to the vines, which were well established and vigorous, was not important, and the chief interest of the facts noted lies in the possible danger to grape vines in the proximity of wild or cultivated *Ampelopsis* plants, which may serve as an important source of infection, if their presence is overlooked. The simplest precaution is, naturally, that of rigorously excluding the species named from the neighborhood of grape vines.

Two closely related fungi appeared to a considerable extent on a plot of purple-topped white turnips on the Station grounds in September last. They were the DOWNY MILDEW (*Peronospora parasitica* (P.) Tul.) and the WHITE RUST (*Cystopus candidus* (Pers.) Lev.) of cruciferous plants. They often appear together, and sometimes do considerable damage. Any field on which they

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\* Journal of Mycology, 1889, p. 202.

appeared, and on which it is intended to plant turnips, cabbages, radishes, or any cruciferous crop, the next year, should be carefully cleaned of all refuse, leaves, etc., as soon as the crop is harvested; since these fungi winter by means of resting spores developed in the leaves and stems, and set free by their decay.

Early potatoes have been an almost total loss throughout the State, on account of the attacks of the POTATO-ROT fungus (*Phytophthora infestans* (Mont.) de By.). As the weather early in the season was not especially favorable to the development of the fungus, early potatoes were, as a rule, harvested in excellent condition; but a period of cool, moist weather in September was fatal to the late crop.

A few complaints of rotting were received early in the season, but whenever specimens were sent they showed the rot fungus, but merely a browning and shrivelling, due probably to the rather severe drought prevailing at the time.

In accordance with a request, the following brief description of the characteristic appearance of leaves attacked by the rot fungus is here given. The spots, at first yellow, soon become of a dark-brown or blackish, muddy color, very different from the clearer and lighter brown of merely dried leaves. Another peculiarity of these spots is their rotten condition, very different from that produced by the rust fungus, or by most other fungi. Around the edges of the spots may usually be observed, on close examination, especially with a hand magnifier, and chiefly on the lower surface of the leaf, a delicate white "fuzz," composed of the fruiting threads of the fungus. The disease usually appears first at some part of a field, and thence spreads, generally in a definite direction, with the prevailing wind. Only the promptest action can save a field where the disease has begun to spread; but it has been repeatedly shown that the sufficiently prompt and frequent application of the plants of the Bordeaux mixture, the materials for which must be kept on hand, will avert a very large part of the threatened loss.

THE ELDER RUST (*Æcidium Sambuci* Schw.) has been very abundant during the past season on our common elder

(*Sambucus Canadensis*), and its cultivated variety *aurea*, and was sent from Brookline by W. H. Manning, Esq., who reported it as greatly disfiguring the ornamental cut-leaved black elder (*S. nigra*, var. *laciniata*). It occurs on the leaf blades and stalks, where it causes the normal tissue to become greatly overdeveloped, producing large, fleshy masses, which distort the leaf and bear the spore cups on their surfaces.

The fungus is one which is difficult to deal with, as so little is known of its life history. It is the *cluster-cup* stage of one of the rust fungi, and none of the other stages has been found on the elder. It is probable that these occur on some other host plant; but, until the connection is established, little can be done to prevent its attacks, except to remove the affected foliage and burn it. The fact of the prevalence of the fungus in one season, however, does not prevent its being very rare in the next; and the controlling conditions are, as yet, very little understood.

THE RUST OF BLACKBERRIES AND RASPBERRIES (*Cæoma nitens* Schw.) is one of the commonest and most striking of our fungi. It produces at first a stunted and yellowish appearance of the shoots attacked, which is soon followed by the development of the spores in brilliant orange patches, almost or quite covering the lower surfaces of the leaves.

Experiments point to the probability that its spread by means of its spores can be checked by spraying with the Bordeaux mixture; but when a plant is once attacked there is no alternative but to dig it up and burn it, since the vegetative threads of the fungus live through the winter in the stalks, and thence penetrate the new shoots and leaves in the spring, developing the spores on the leaves. The spores are summer spores and have not yet been proved to be connected with any resting-spore form, but it is not improbable that such a connection may yet be traced; though its ability to hibernate in the host plant makes it possible that we have to deal with an independent form.

THE HOLLYHOCK RUST (*Puccinia Malvacearum* Mont.) has become, within a few years, an important disease in Massachusetts. It is a native of Chili, whence it was intro-

into Europe some years ago. In 1885 it was brought to this country with some imported *Malope* planted at Beverly Farms, Mass., and spread to the hollyhocks there in 1886. From this point, or possibly from other points as it extended, appearing in Boston, Cambridge, Nahant and elsewhere, and has been recently observed in central New York. It was forwarded this year to the station by Mr. Lovett, Esq., of West Newton.

The spores have the structure of the resting spores of *Uromyces*, but are not resting spores, since they germinate readily, and infect new plants. Perhaps the last spores of the season are resting spores, by which the fungus survives the winter, as has been shown to be the case with some other species. Affected plants should be promptly cut out and destroyed, if it is desired to protect those not yet harmed.

**CASE OF OATS.** — The Massachusetts Crop Report for 1890, contained numerous complaints, especially from the western counties, of the failure of oats from "rusting;" the October Report mentions oats among the crops which generally failed throughout the State. Letters to the Crop Report correspondents in Barre, Deerfield and Newburyport brought replies and specimens of the affected oats, to which the gentlemen named have the thanks of this Department. In every case the plants had a general yellow or "rusty" color, but their appearance was quite different from that of plants attacked by the grain-rust (*Puccinia graminis* Pers., *P. coronata* Cda., etc.). No fungus or animal could be detected in any part of the plants, but Bacteria were always present. Other work prevented any detailed study of the trouble; but there is no doubt that it is the same which was very generally reported from the Eastern and Central States, and which materially reduced the oat crops of those sections. The disease has been investigated by the Division of Vegetable Pathology of the United States Department of Agriculture, and is regarded as caused by a specific Bacterium.

\* Until our knowledge of it is much more com-

plete, no recommendations concerning treatment can be made; and, indeed, it is by no means improbable that it may prove to be so dependent upon meteorological and other conditions as not to occur again for a long period, as has been suggested.

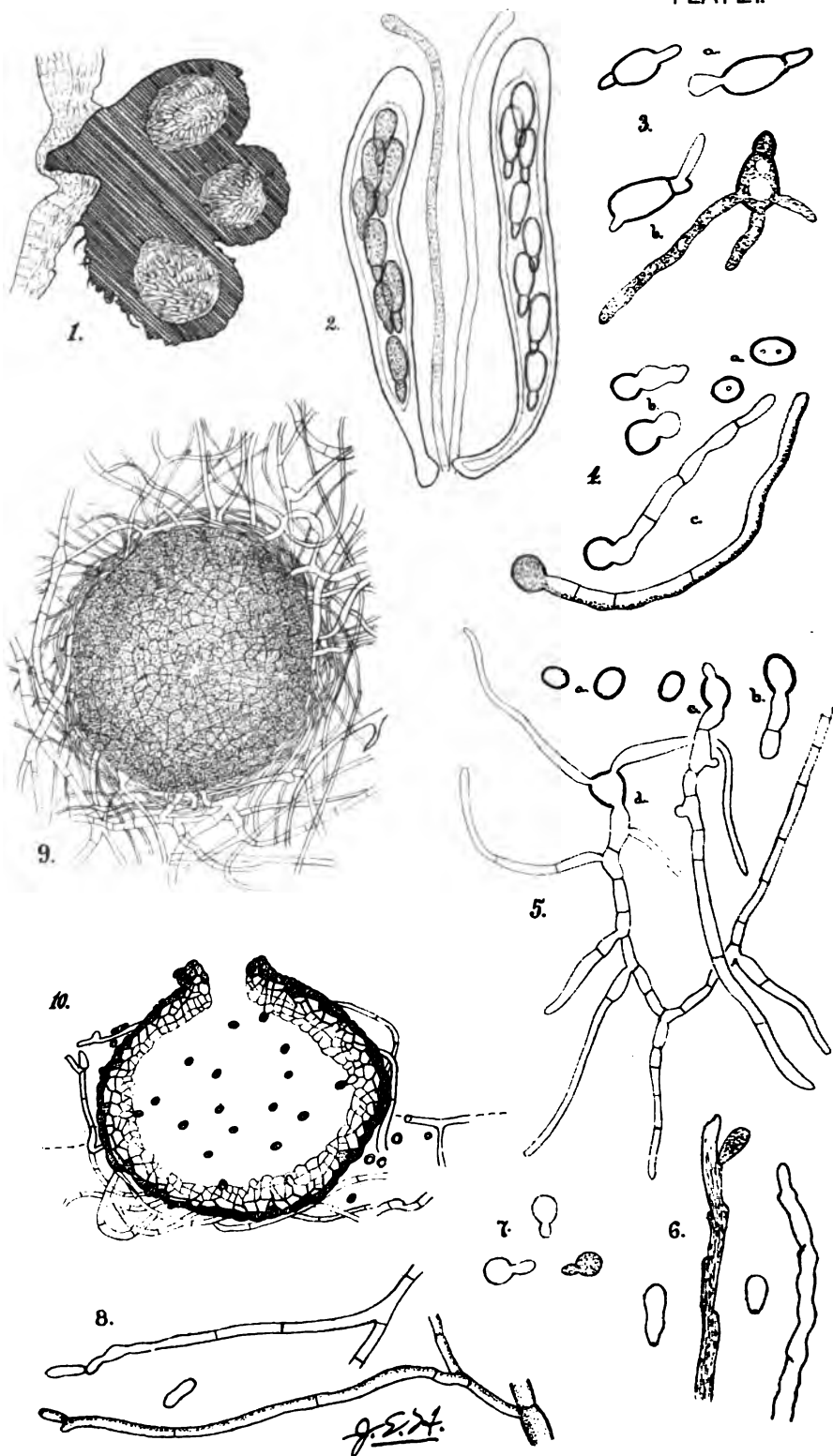
#### NOTE ON FUNGICIDES.

Formulae for some of the most useful fungicides were given in our last report, at page 212. The materials for the preparation of these and others, together with an effective spraying pump, were purchased by the station last spring, in the expectation that we should be able to test them on crops on the station plots during the season. No fungous disease appeared on any crop, however, to such a degree as to render any test of fungicides possible, and the outfit and materials remain in our hands for use next season, should circumstances favor. Full directions for preparing and applying such fungicides as the latest experience has shown to be most valuable will be given in a bulletin of this station early next spring.





PLATE I.



## EXPLANATION OF PLATE I.

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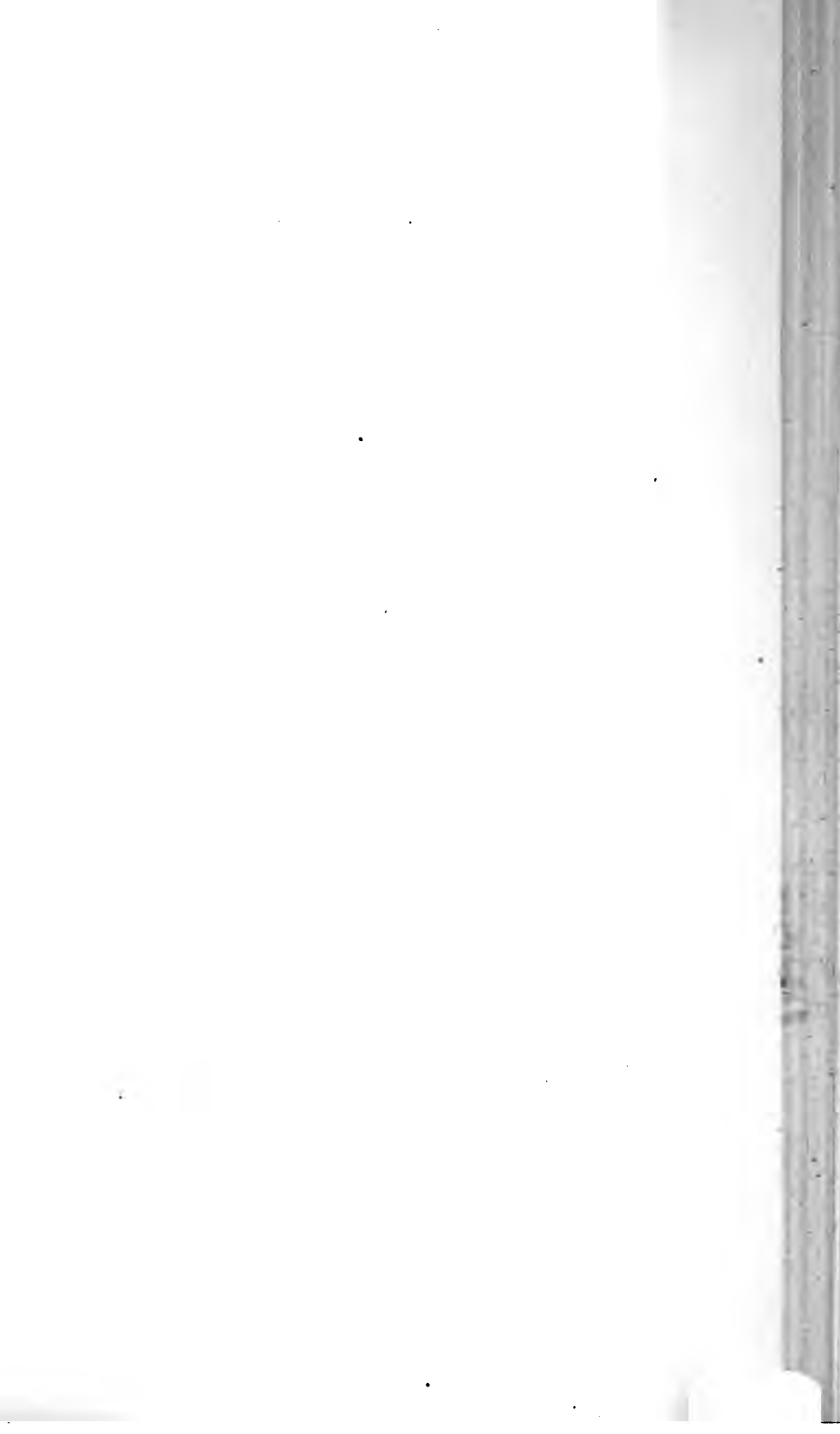
### *The Fungus of Black Knot. (Plowrightia Morbosa (Sz.) Sacc.)*

- g. 1. Diagrammatic representation of a section through three perithecia containing spore sacs (*asci*). x 72.\*
- g. 2. Two sacs containing ripe spores, and two sterile threads (*paraphyses*). x 940.
- g. 3. Four winter spores (*ascospores*), germinating in water; *a*, after one day; *b*, after two days. x 940.
- g. 4. Six *pycnospores* from a knot; *a*, just placed in water; *b*, after one day; *c*, after two days in water. x 940.
- g. 5. Six *pycnospores* from a *pycnidium* developed on gelatine from winter spores; *a*, three fresh spores; *b*, a spore after one day in water; *c*, a spore after two days in water; *d*, a spore after two days on nutrient gelatine. *d* x 540; others x 940.
- g. 6. Three summer spores (*conidia*), with two of the threads on which they are borne. x 940.
- g. 7. Three summer spores beginning to germinate after one day on nutrient gelatine. x 940.
- g. 8. Threads bearing new crop of summer spores produced on gelatine culture of summer spores from young knot, shown in Figs. 6 and 7. x 540.
- g. 9. Surface view, from above, of a *pycnidium* developed on gelatine from winter spores. x 350.
- g. 10. Vertical section through such a *pycnidium*, showing origin of spores. x 350.  
Drawn chiefly from a single section, but completed in some details from others. The threads about the mouth are not shown in the section.

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The number given after each figure represents the degree of magnification of the original drawing, which has been reduced about one-third in this plate. The magnification of the figures, here given, is therefore about two-thirds of that indicated by the printed numbers.





## EXPLANATION OF PLATE II.

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### *The Cucumber Mildew. (Plasmopara Cubensis) (B. & C.)*

- Fig. 11. A conidial thread arising from a vegetative thread; *sp.*, two summer spores (*conidia*). x 540.\*
- Fig. 12. A portion of a vegetative thread giving rise to two conidial threads through the same leaf-pore. x 540.
- Fig. 13. A young conidial thread with the spores not yet fully developed and still in place. x 540.
- Fig. 14. A portion of a vegetative thread among the cells of a leaf, four of which are shown, and penetrating them by its *haustoria*, *h.* x 540.

### *The Mildew of the Star Cucumber. (Plasmopara australis Spag.)*

- Fig. 15. A conidial thread and spores; *a* x 350 ; *sp.* spores x 540.
- Fig. 16. A portion of a vegetative thread, with *haustoria*, *h.* x 540.

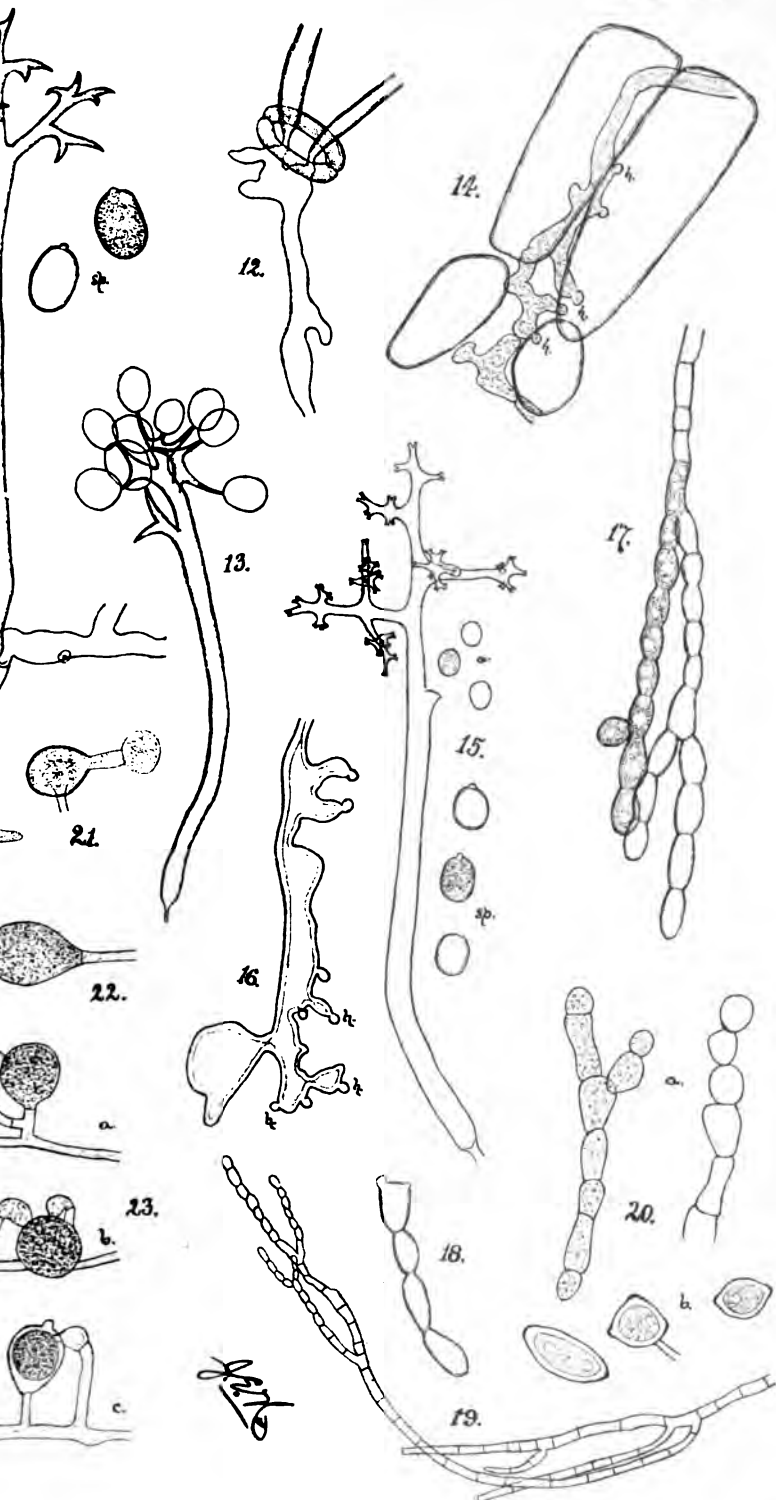
### *The Brown Rot of Stone Fruits. (Monilia fructigena Pers.)*

- Fig. 17. Spore chains. x 540.
- Fig. 18. End of a growing chain, showing beginnings of new spores and origin of branching. x 540.
- Fig. 19. Threads terminating in spore chains, developed in five days from spores sown on nutrient gelatine. x 200.
- Fig. 20. Threads, *a*, and resting cells (*Gemma*), *b*, from the flesh of "mummied" plums, in winter. x 540.

### *The "Damping-off" Fungus. (Pythium de Baryanum Hesse.)*

- Fig. 21. Two *zoösporangia*, showing beginnings in formation of *zoöspores*. x 540.
- Fig. 22. A resting cell (*Gemma*). x 540.
- Fig. 23. Sexual organs; *a*, female cell (*oögonium*), with a single male (*antheridium*); *b*, with two males; *c*, resting spore (*oöspore*), formed and fertilized as shown by emptying of male cell. x 540.
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\* See note to Plate I.





## SPECIAL WORK IN THE CHEMICAL LABORATORY.

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- I. Communication on commercial fertilizers : —
  1. General introduction.
  2. Laws for the regulation of the trade in commercial fertilizers.
  3. List of licensed manufacturers for May 1, 1889, to May 1, 1890.
  4. Analyses of licensed fertilizers.
  5. Analyses of commercial fertilizers and manurial substances sent on for examination.
  6. Miscellaneous analyses.
- II. Water analyses.
- III. Compilation of analyses made at Amherst, Mass., of agricultural chemicals and refuse materials used for fertilizing purposes.
- IV. Compilation of analyses made at Amherst, Mass., of fodder articles, fruits, sugar-producing plants, dairy products, etc.





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## I. COMMUNICATION ON COMMERCIAL FERTILIZERS.

1. General introduction.
2. Laws for the regulation of the trade in commercial fertilizers.
3. List of licensed manufacturers for May 1, 1889, to May 1, 1890.
4. Analyses of licensed fertilizers.
5. Analyses of commercial fertilizers and manurial substances sent on for examination.
6. Miscellaneous analyses.

*1. General Introduction.*

The trade in commercial fertilizers has been quite active in our State during the past year. Fifty-one manufacturers and dealers in manurial substances have applied for and received certificates for their compliance with our State laws for the regulation of the trade in commercial fertilizers; twenty-nine of these are residing in the State, while twenty-two are residents of other States.

One hundred and fifty-eight samples of licensed articles of various description have been collected in all parts of the State by a duly authorized agent of the station. They were analyzed at the chemical laboratory of the latter, with the following results: fifty-four samples contained one single essential constituent below the lowest guaranty; ten samples contained two essential constituents below the lowest guaranty; three samples contained all three essential constituents below the lowest guaranty; fifty-six samples contained one essential constituent above the highest guaranty; thirteen samples contained two essential constituents above the highest guaranty; four samples contained all three essential constituents above the highest guaranty. The deficiency in regard to one or two essential constituents was in the majority of cases commercially compensated by the excess of another one.

The fluctuation in the market price of most standard articles used in the manufacture of compound fertilizers has been within the usual limits during the past season. Tankage, nitrate of soda, blood, azotin and sulphate of

potash declined during the middle of May. Bones, refuse bone-black and crude phosphate rock have remained unchanged in price since January 1. Muriate of potash and kainite held their own, while sulphate of ammonia advanced somewhat. Judging from present indications, some changes regarding the cost of commercial fertilizers may be expected for the coming season.

The duties assigned to the director of the station, to act as inspector of commercial fertilizers, render it necessary to discriminate, in official publications of the results of analyses of commercial fertilizers and of manurial substances in general made at the station, between analyses of samples collected by a duly qualified delegate of the experiment station, in conformity with the rules prescribed by the new laws, and those analyses which are made of samples sent on for that purpose by outside parties. In regard to the former alone can the director assume the responsibility of a carefully prepared sample, and of the identity of the article in question.

The official report of analyses of compound fertilizers and of all such materials as are to be used for manurial purposes, which are sold in this State under a certificate of compliance with the present laws for the regulation of the trade in these articles, has been restricted by our State laws to a statement of chemical composition, and to such additional information as relates to the latter. The practice of affixing to each analysis of this class of fertilizers an approximate commercial valuation per ton of their principal constituents has, therefore, been discontinued. This change, it is expected, will tend to direct the attention of the consumers of fertilizers more forcibly towards a consideration of the particular composition of the different brands of fertilizers offered for their patronage,—a circumstance not unfrequently overlooked.

The approximate market value of the different brands of fertilizers, obtained by the current mode of valuation, does not express their respective agricultural value, *i.e.*, their crop-producing value; for the higher or lower market price of different brands of fertilizers does not necessarily stand in a direct relation to their particular fitness, without

any reference to the particular condition of the land to be treated, and the special wants of the crops to be raised, to their assistance. To select judiciously, from a variety of brands of fertilizers offered for patronage, the farmer has to feel confident that the particular brand of fertilizer in question actually contains the guaranteed quantities of the three essential qualities of essential articles of plant food at a reasonable cost, and that it contains them in such form and in such proportions as will best meet existing circumstances and the special wants. In some cases it may be mainly either phosphoric acid or nitrogen or potash; in others, two of these; in others again, all three.

A remunerative use of commercial fertilizers can only be secured by attending carefully to the above-stated considerations.

To assist farmers not yet familiar with the correct method of determining the commercial value of manures and fertilizers offered for sale in our markets, some of the principal considerations, which serve as a basis for the correct commercial valuation, are once more stated with reference to the subsequent pages.

The hitherto customary valuation of manurial materials is based on the average trade value of the essential fertilizing elements specified by analysis. The money value of the higher grades of agricultural chemicals, and of the higher-priced compound fertilizers, depends in the majority of cases on the amount and the particular form in which the three essential articles of plant food — *i.e.*, phosphoric acid, nitrogen and potash — which they contain. To determine by this mode of valuation, the approximate money value of a fertilizer (*i.e.*, the money worth of its essential fertilizing ingredients), we multiply the pounds per ton of phosphoric acid, etc., by the trade value per pound; the same method is adopted with reference to the various forms of nitrogenous acid and of potassium oxide. We thus get the value of each ton of the several ingredients, and, adding them together, we obtain the total valuation per ton in case of fertilizers sold at points of general distribution.

The market value of low-priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barn-yard manure, factory refuse and waste materials of different description, quite frequently does not stand in a close relation to the market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation, and more or less advantageous mechanical condition for a speedy action, exert, as a rule, a decided influence on their selling price.

The mechanical condition of any fertilizing material, simple or compound, deserves the most serious consideration of farmers, when articles of a similar chemical character are offered for their choice. The degree of pulverization controls, almost without exception, under similar conditions, the rate of solubility, and the more or less rapid diffusion of the different articles of plant food throughout the soil.

The state of moisture exerts a no less important influence on the pecuniary value in case of one and the same kind of substance. Two samples of fish fertilizers, although equally pure, may differ from fifty to one hundred per cent. in commercial value, on account of mere difference in moisture.

Crude stock for the manufacture of fertilizers, and refuse materials of various descriptions, have to be valued with reference to the market price of their principal constituents, taking into consideration at the same time their general fitness for speedy action.

*Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals.*

	1890. Cents per Pound.
Nitrogen in ammoniates, . . . . .	17
Nitrogen in nitrates, . . . . .	14½
Organic nitrogen in dry and fine ground fish, meat, blood, .	17
Organic nitrogen in cotton-seed meal and castor pomace, .	15
Organic nitrogen in fine ground bone and tankage, . . .	16½
Organic nitrogen in fine-ground medium bone and tankage, .	13
Organic nitrogen in medium bone and tankage, . . . .	10½

*Trade Values of Fertilizing Ingredients in Raw Materials — Concluded.*

Organic nitrogen in coarser bone and tankage, . . . . .	
Organic nitrogen in hair, horn-shavings and coarse fish scraps, . . . . .	
Phosphoric acid soluble in water, . . . . .	
Phosphoric acid soluble in ammonium citrate, . . . . .	
Phosphoric acid in dry ground fish, fine bone and tankage, . . . . .	
Phosphoric acid in fine medium bone and tankage, . . . . .	
Phosphoric acid in medium bone and tankage, . . . . .	
Phosphoric acid in coarse bone and tankage, . . . . .	
Phosphoric acid in fine-ground rock phosphate, . . . . .	
Potash as high-grade sulphate, and in forms free from muriate or chlorides, ashes, etc., . . . . .	
Potash as kainite, . . . . .	
Potash as muriate, . . . . .	

The organic nitrogen in superphosphates, special and mixed fertilizers of a high grade, is usually valued at the highest figures laid down in the trade values of fertilizing ingredients in raw materials, namely, seventeen cents per pound; it being assumed that the organic nitrogen is derived from the best sources, viz., animal manure, meat, blood, bones, or other equally good forms of nitrogen from leather shoddy, hair, or any low-priced form of vegetable matter, unless the contrary is ascertained. For similar reason, the insoluble phosphoric acid is valued in this connection at three cents, it being assumed, unless found otherwise, that it is from bone or similar sources and not from rock phosphate. In this latter form of phosphoric acid is worth but two cents per pound.

The above trade values are figures at which, for the six months preceding March, 1890, the respective materials could be bought at retail for cash in our large markets for the raw materials, which are the regular sources of supply.

They also correspond to the average wholesale prices for the six months ending March 1, plus about ten per cent. in case of goods for which we have no quotations. The valuations obtained by use of the above figures will be found to agree fairly with the retail prices in the large markets of standard raw materials, such as

Sulphate of ammonia,	Dry ground fish,
Nitrate of soda,	Azotin,
Muriate of potash,	Ammonite,
Sulphate of potash,	Castor pomace,
Dried blood,	Bone and tankage,
Dried ground meat,	Plain superphosphates.

A large percentage of commercial materials consists of refuse matter from various industries. The composition of these substances depends upon the mode of manufacture carried on. The rapid progress in our manufacturing industries is liable to affect, at any time, more or less seriously, the composition of the refuse. To assist the farming community in a clear and intelligent appreciation of the various substances sold for manurial purposes, a frequent examination into the temporary characters of agricultural chemicals and refuse materials offered in our markets for manurial purposes is constantly carried on at the laboratory of the station.

Consumers of commercial manurial substances do well to buy, whenever practicable, on guarantee of composition with reference to their essential constituents; and to insist on it that the bill of sale recognizes that point of the bargain. A mistake or misunderstanding may be readily avoided, in that case, between the contending parties. The responsibility of the dealer ends with furnishing an article corresponding, in its composition, with the lowest specified quantity of each specified essential constituent. Our present laws for the regulation of the trade in commercial fertilizers include not only the various brands of compound fertilizers, but also all materials, single or compound, without reference to source, used for manurial purposes, when offered for sale on our market at ten dollars or more per

Copies of our present laws for the regulation of the trade in commercial fertilizers may be had by all interested, on application at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.



## 2. *Laws for the Regulation of the Trade in Commercial Fertilizers.*

[CHAP. 296.]

AN ACT TO REGULATE THE SALE OF COMMERCIAL FERTILIZERS.  
*Be it enacted, etc., as follows:*

SECTION 1. Every lot or parcel of commercial fertilizer material used for manurial purposes sold, offered or exposed for sale within this Commonwealth, the retail price of which is ten dollars or more per ton, shall be accompanied by a plain statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand, or trade-mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the place of manufacture, and a chemical analysis stating the percentage of nitrogen or its equivalent ammonia, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and free from iron, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials, said label shall contain a correct general statement of the composition and ingredients of the fertilizer it accompanies.

SECT. 2. Before any commercial fertilizer, the retail price of which is ten dollars or more per ton, is sold, offered or exposed for sale, the importer, manufacturer or party who causes it to be sold or offered for sale within the state of Massachusetts, shall deposit with the director of the Massachusetts agricultural experiment station a certified copy of the statement named in section one and shall also deposit with said director at his request a sample of the fertilizer in a glass jar or bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

SECT. 3. The manufacturer, importer, agent or seller of any brand of commercial fertilizer or material used for manurial purposes, the retail price of which is ten dollars or more per ton, shall pay for each brand, on or before the first day of May next following, to the director of the Massachusetts agricultural experiment station an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus, and potash, contained or claimed to exist in said brand or fertilizer. And that whenever the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller of such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on the payment of said analysis fees and statement specified in section

director of said station shall issue certificates of compliance with  
s act.

SECT. 4. No person shall sell, offer or expose for sale in the  
te of Massachusetts, any pulverized leather, raw, steamed,  
asted, or in any form as a fertilizer, or as an ingredient of any  
tilizer or manure, without an explicit printed certificate of the  
t, said certificate to be conspicuously affixed to every package  
such fertilizer or manure and to accompany or go with every  
reel or lot of the same.

SECT. 5. Any person selling, offering or exposing for sale, any  
mmercial fertilizer without the statement required by the first  
tion of this act, or with a label stating that said fertilizer con-  
ns a larger percentage of any one or more of the constituents  
ntioned in said section than is contained therein, or respecting  
e sale of which all the provisions of the foregoing section have  
t been fully complied with, shall forfeit fifty dollars for the  
st offence, and one hundred dollars for each subsequent offence.

SECT. 6. This act shall not affect parties manufacturing, im-  
rting or purchasing fertilizers for their own use, and not to sell  
this state.

SECT. 7. The director of the Massachusetts agricultural experi-  
ment station shall pay the analysis fees, as soon as received by  
n, into the treasury of the station, and shall cause one analysis  
more of each fertilizer or material used for manurial purposes  
be made annually, and publish the results monthly, with such  
ditional information as circumstances advise: *provided*, such  
ormation relate only to the composition of the fertilizer or  
tilizing material inspected. Said director is hereby authorized  
person or by deputy to take a sample, not exceeding two pounds  
weight, for analysis, from any lot or package of fertilizer or  
y material used for manurial purposes which may be in the  
ssession of any manufacturer, importer, agent or dealer; but  
d sample shall be drawn in the presence of said party or parties  
interest or their representative, and taken from a parcel or a  
mber of packages which shall be not less than ten per cent. of  
e whole lot inspected, and shall be thoroughly mixed and then  
rided into two equal samples and placed in glass vessels and  
refully sealed and a label placed on each, stating the name or  
and of the fertilizer or material sampled, the name of the party  
om whose stock the sample was drawn and the time and place  
drawing, and said label shall also be signed by the director or  
deputy and by the party or parties in interest or their represent-  
ves present at the drawing and sealing of said sample; one of  
d duplicate samples shall be retained by the director and the

other by the party whose stock was sampled. All parties engaged in this act shall be prosecuted by the director of agriculture, but it shall be the duty of said director, upon ascertaining a violation of this act, to forthwith notify the manufacturer or importer in writing, and give him not less than thirty days in which to comply with the requirements of this act, but there shall be no prosecution in relation to the quality of the fertilizing material if the same shall be found substantially equivalent to the statement of analysis made by the manufacturer or importer.

SECT. 8. Sections eleven to sixteen inclusive of chapter 106 of the Public Statutes are hereby repealed.

SECT. 9. This act shall take effect on the first day of January in the year eighteen hundred and eighty-eight, [April 3, 1888.]

*Instructions issued, at the Beginning of the Season, to the Manufacturers and Importers of Commercial Fertilizers.*

1. An application for a certificate of compliance with the regulations of the trade in commercial fertilizers and materials for manurial purposes in this State must be accompanied by:

*First*, with a distinct statement of the name of the fertilizer offered for sale.

*Second*, with a statement of the amount of phosphoric acid, nitrogen and of potassium oxide guaranteed in each district.

*Third*, with the fee charged by the State for a certificate. The fee is five dollars for each of the following articles: nitrogen, phosphoric acid and potassium oxide guaranteed in any district.

2. The obligation to secure a certificate applies to all compound fertilizers, but to all substances, single or mixed, used for manurial purposes, and offered for sale at less than one dollar more per ton of two thousand pounds.

3. The certificate must be secured annually before the first of January.

4. Manufacturers, importers and dealers in commercial fertilizers can appoint in this State as many agents as they desire, after having secured at this office the certificate of compliance with our laws.

5. Agents of manufacturers, importers and dealers in commercial fertilizers are held personally responsible for their transactions until they can prove that the articles they offer for sale are recorded in this office.

6. Manufacturers and importers are requested to furnish the names of their agents.

7. All applications for certificates ought to be addressed to the Director of the Massachusetts State Agricultural Experiment Station.

*List of Dealers who have secured Certificates for the Sale of Commercial Fertilizers in This State during the Past Year, and the Brands licensed by Each.*

Frank Coe, New York, N. Y. :—

High-grade Ammoniated Bone Superphosphate.

Fish and Potash.

Potato Fertilizer.

Gold Brand Excelsior Guano.

Standard Fertilizer Company, Boston, Mass. :—

Standard Fertilizer.

Standard Superphosphate.

S. Miller & Co., Newark, N. J. :—

Standard Superphosphate of Lime.

Ammoniated Dissolved Bone Phosphate.

Potato Fertilizer.

Ground Bone.

E. Soper & Co., Boston, Mass. :—

Cotton-seed Hull Ashes.

Under Wilcox, Mystic Bridge, Conn. :—

Dry Ground Fish Guano.

Acidulated Fish Guano.

L. Butman, Lowell, Mass. :—

Lowell Bone Fertilizer.

S. Reese & Co. Baltimore, Md., licensees of Clark's Cove

Guano Company, New Bedford, Mass. :—

Bay State Fertilizer.

Concentrated Manure for Corn and Potatoes.

King Philip Alkaline Guano.

Great Planet A. A. Manure.

Fish and Potash.

New England Favorite.

Pilgrim Fertilizer.

H. Smith, Northborough, Mass. :—

Steamed Bone.

Whittemore Bros., Wayland, Mass. :—

Whittemore's Complete Manure.

Ames Fertilizer Company, Peabody, Mass. :—

Ames' Bone Fertilizer.

E. Holmes, Worcester, Mass. :—

Steamed Bone.

3. *List of Dealers who have secured Certificates, etc*

- J. C. Dow & Co., Boston, Mass. : —  
 Nitrogenous Superphosphate.  
 Ground Bone Fertilizer.  
 Fine-ground Bone.
- N. Ward Company, Boston, Mass. : —  
 High-grade Animal Fertilizer.
- Hargrave Manufacturing Company, Fall River, Mass.  
 Steamed Bone.
- Bradley Fertilizer Company, Boston, Mass. : —  
 XL Phosphate.  
 B. D. Sea-fowl Guano.  
 Coe's Original Superphosphate of Lime.  
 Fish and Potash.  
 Pure Fine-ground Bone.  
 Bradley's Complete Manures : —  
 For Potatoes and Vegetables.  
 For Corn and Grain.  
 For Top-dressing Grass and Grain.  
 Bradley's Grass Manure for Top-dressing.  
 Bradley's Potato Manure.  
 Nitrate of Soda.  
 Sulphate of Ammonia.  
 Muriate of Potash.  
 Dissolved Bone-black.
- A. Lee & Co., Boston, Mass. : —  
 Lawrence Fertilizer.  
 Ground Bone.
- Lister's Agricultural Chemical Works, Newark, N. J. : —  
 Standard Superphosphate of Lime.  
 Ammoniated Dissolved Bone.
- W. D. Stewart & Co., Boston, Mass. : —  
 Soluble Pacific Guano.
- Cleveland Dryer Company, Boston, Mass. : —  
 Cleveland Potato Phosphate.  
 Cleveland Superphosphate.
- Cumberland Bone Company, Portland, Me. : —  
 Cumberland Superphosphate.  
 Seeding-down Fertilizer.

*List of Dealers who have secured Certificates, etc. — Continued.*

ad Fertilizer Company, Syracuse, N. Y. :—

Farmers' Friend.

Lion Brand.

High-grade Farmers' Friend Special.

Sampson Brand, or Lion Special.

J. Brightman & Co., Tiverton, R. I. :—

Fish and Potash.

Superphosphate.

Dry Ground Fish.

ams & Thomas, Springfield, Mass. :—

Adams' Market Bone Fertilizer.

B. Darling Fertilizer Company, Pawtucket, R. I. :—

Darling's Animal Fertilizer.

Extra Bone Phosphate.

Potato and Root-crop Manure.

Pure Bone.

Muriate of Potash.

Sulphate of Potash.

eph Church & Co., Tiverton, R. I. :—

Fish and Potash.

Church's Special.

Church's Standard.

Dried and Ground Fish.

C. Sturtevant, Hartford, Conn. :—

Tobacco and Sulphur Fertilizer.

mund Hersey, Hingham, Mass. :—

Steamed Bone.

rest City Wood Ash Company, London, Ontario :—

Unleached Wood Ashes.

E. Mayo & Co., Boston, Mass. :—

Mayo's Superphosphate.

eat Eastern Fertilizer Company, Rutland, Vt. :—

Great Eastern General, for Grain and Grass.

Great Eastern Vegetable, Vine and Tobacco Fertilizers.

Great Eastern General, Oats, Buckwheat and Seeding-down  
Phosphate.

ddford Winter, Brockton, Mass. :—

Steamed Bone.

3. *List of Dealers who have secured Certificates, etc.* —

Prentiss, Brooks & Co., Holyoke, Mass. : —

Dry Fish.  
Dissolved Bone-black.  
Muriate of Potash.  
Nitrate of Soda.  
Sulphate of Potash.

Mapes Formula and Peruvian Guano Company, New York :

The Mapes Bone Manures.  
Peruvian Guano.  
Mapes Superphosphate.  
Mapes Special Crop Manures.

Bowker Fertilizer Company, Boston, Mass. : —

Stockbridge Manures.  
Hill and Drill Phosphate.  
Lawn and Garden Fertilizer.  
Ammoniated Bone Fertilizer.  
Fish and Potash.  
Dry Ground Fish.  
Gloucester Fish and Potash.  
Fine-ground Bone.  
Plain Superphosphate.  
Kainite.  
Nitrate of Soda.  
Dried Blood.  
Dissolved Bone-black.  
Muriate of Potash.  
Sulphate of Potash.

C. A. Bartlett, Worcester, Mass. : —

Pure Ground Bone.  
Animal Fertilizer.

W. E. Fyfe & Co., Clinton, Mass. : —

Unleached Wood Ashes.

Quinnipiac Fertilizer Company, New London, Conn. : —

Quinnipiac Phosphate.  
Quinnipiac Potato Manure.  
Quinnipiac Dry Ground Fish.  
Quinnipiac Fish and Potash.  
Muriate of Potash.  
Sulphate of Potash.

*List of Dealers who have secured Certificates, etc. — Continued.*

John G. Jefferds, Worcester, Mass. : —

Jefferds' Animal Fertilizer.

Jefferds' Fine-ground Bone.

Rocker Fertilizer and Chemical Company, Buffalo, N. Y. : —

New Rival Ammoniated Superphosphate.

Buffalo Superphosphate, No. 2.

Special Potato Manure.

Pure Ground Bone.

Ammoniated Bone Superphosphate.

Potato, Hop and Tobacco Phosphate.

Queen City Phosphate.

Vegetable Bone Superphosphate.

Ammoniated Wheat and Corn Phosphate.

James E. McGovern, Lawrence, Mass. : —

West Andover Market Bone Phosphate.

Fine-ground Bone.

American Manufacturing Company, Boston, Mass. : —

The Allen Fertilizer.

Thomas Hersom & Co., New Bedford, Mass. : —

Fine-ground Bone.

Meat and Bone.

J. Baker & Bro., New York, N. Y. : —

A. A. Ammoniated Superphosphate.

Pelican Bone Fertilizer.

Potato Manure.

Junroe, Judson and Stroup, Oswego, N. Y. : —

Unleached Wood Ashes.

Geo. W. Miles Fertilizer and Oil Company, Milford, Conn. : —

IXL Ammoniated Bone Superphosphate.

Fish and Potash.

Joseph Breck & Son, Boston, Mass. : —

Breck's Lawn and Garden Dressing.

National Fertilizer Company, Bridgeport, Conn. : —

Chittenden's Complete Fertilizer.

Chittenden's Fish and Potash.

Chittenden's Universal Phosphate.

Ground Bone.

Peabody's Fertilizer Company, New York, N. Y. : —

Ammoniated Bone Superphosphate.

American Guano.



3. *List of Dealers who have secured Certificates, etc.* —

Davidge Fertilizer Company, New York, N. Y. : —

Potato Manure.

Vegetator.

Special Favorite.

The Le Page Company, Boston, Mass. : —

Red Star Brand 203 Fertilizer.

Red Star Brand Special Potato Fertilizer.

William Lavery, Amesbury, Mass. : —

Lavery's Superphosphate.

Steamed Bone.

# 4. Analyses of Commercial Fertilizers collected during the Past Season at Station, of the Massachusetts Agricultural Experiment

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	<i>Compound Fertilizers.</i>		
1	Tuttle's Fish,	Prentiss, Brooks & Co., Holyoke, Mass.,	Hatfield.
3	Whittemore's Complete Manure,	Whittemore Bros., Wayland, Mass.,	Wayland.
4	Lowell Bone Fertilizer,	J. M. Butman, Chelmsford, Mass.,	Chelmsford.
8	Potato Manure,	M. J. Baker & Bro., New York, N. Y.,	Boston.
14	Hill and Drill Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	North Sudbury.
19	Fish and Potash,	Joseph Church & Co., Tiverton, R. I.,	Springfield.
25	Adams' Market Bone Fertilizer,	Adams & Thomas, Springfield, Mass.,	Frammingham.
37	Vegetable, Vine and Tobacco Fertilizer,	Great Eastern Fertilizer Company, Rutland, Vt.,	North Frammingham.
39	Potato and Root Crop Manure,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Frammingham.
41	Original Bay State Bone Superphosphate,	J. A. Tucker & Co., Boston, Mass.,	Northborough.
44	Ammoniated Bone Superphosphate,	National Fertilizer Company, Bridgeport, Conn.,	Lawrence.
54	Darling's Pure Dissolved Bone,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Amherst.
67	Wilcox's Dry Ground Fish Guano,	Leander Wilcox, Mystic Bridge, Conn.,	Northampton.
77	Quinnipiac Dry Ground Fish,	The Quinnipiac Company, New London, Conn.,	
	<i>Bones.</i>		
2	Steamed Bone,	E. H. Smith, Northborough, Mass.,	Northborough.
5	Bone Flour,	H. S. Miller & Co., Newark, N. J.,	Boston.
6	Ground Bone,	H. S. Miller & Co., Newark, N. J.,	Boston.
16	Steamed Bone,	J. G. Jeffers, Worcester, Mass.,	Worcester.
17	Steamed Bone,	C. A. Bartlett, Worcester, Mass.,	Worcester.
18	Steamed Bone,	G. E. Holmes, Worcester, Mass.,	Worcester.
110	S. Winter's Pure Ground Bone,	S. Winter, Brockton, Mass.,	Brockton.



## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER	Sampled at—
<i>Compound Fertilizers.</i>			
7	The Allen Fertilizer,	American Manufacturing Company, Boston, Mass.,	Boston.
24	Mapes' Potato Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Springfield.
26	Sampson Brand, or Lion Special,	Read Fertilizer Company, New York, N. Y.,	Lee.
27	Fanner's Friend Special,	Read Fertilizer Company, New York, N. Y.,	Lee.
36	Potato Manure,	Bradley Fertilizer Company, Boston, Mass.,	North Adams.
46	Americus Ammoniated Bone Superphosphate,	Williams & Clark Co., New York, N. Y.,	Northborough.
93	Brightman's Dry Ground Fish,	W. J. Brightman & Co., Tiverton, R. I.,	Fall River.
95	Bay State Fertilizer,	John S. Reese & Co., Baltimore, Md.,	New Bedford.
96	Reese's Concentrated Manure for Corn and Potatoes,	John S. Reese & Co., Baltimore, Md.,	New Bedford.
127	Fine-ground Dry Fish,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
<i>Chemicals.</i>			
72	Sulphate of Ammonia,	The Quinnipiac Company, New London, Conn., Agents,	Northampton.
73	Sulphate of Potash,	The Quinnipiac Company, New London, Conn., Agents,	Northampton.
74	Muriate of Potash,	The Quinnipiac Company, New London, Conn., Agents,	Northampton.
86	Muriate of Potash,	Bradley Fertilizer Company, Boston, Mass., Agents,	Worcester.
124	Sulphate of Potash,	Bowker Fertilizer Company, Boston, Mass., Agents,	Northampton.
125	Nitrate of Soda,	Bowker Fertilizer Company, Boston, Mass., Agents,	Northampton.
<i>Bones.</i>			
31	Pure Raw Ground Bone,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Lee.
68	McGovern's Ground Bone,	James E. McGovern, West Andover, Mass.,	West Andover.
103	Pure Fine-ground Bone,	Thos. Herson & Co., New Bedford, Mass.,	New Bedford.
104	Meat and Bone,	Thos. Herson & Co., New Bedford, Mass.,	New Bedford.

## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.			PHOSPHORIC ACID IN ONE HUNDRED POUNDS.						POTASSIUM OXIDE IN ONE HUNDRED POUNDS.		
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	TOTAL.		AVAILABLE.		Found.	Guaranteed.	
								Found.	Guaranteed.	Found.	Guaranteed.			
<i>Compound Fertilizers.</i>														
7	The Allen Fertilizer, . . . . .	7.15	2.22	2.06-2.47	5.12	2.81	3.58	11.51	6-10	7.93	5-8	5.35	4-6	
24	Mapes' Potato Manure, . . . . .	9.09	3.75	3.71-4.12	5.85	3.06	2.53	11.44	-	8.01	8	5.68	6-8	
26	Sampson Brand, or Lion Special, . . . . .	10.12	2.80	2.47-3.30	6.06	2.66	2.60	11.32	10-12	8.72	8-10	4.18	-*	
27	Farmer's Friend Special, . . . . .	13.70	4.30	3.3-4.12	3.40	1.90	2.56	7.86	6-7	5.30	5-6	10.02	10-12	
36	Potato Manure, . . . . .	12.30	2.19	2.5-3.25	4.67	1.46	1.71	9.84	8-11	8.13	6-8	5.27	5-6	
46	American Ammoniated Bone Superphosphate, . . . . .	13.70	1.94	2-3	8.96	1.27	1.80	12.03	11-16	10.23	9-11	2.36	2-3	
93	Brightman's Dry Ground Fish, . . . . .	9.47	8.36	8.21-9.88	0.49	4.71	5.09	10.20	-	5.20	-	-	-	
93	Bay State Fertilizer, . . . . .	9.86	2.38	2.4-3.3	6.52	6.94	3.48	16.94	-	13.46	9-12	1.93	2-3	
96	Rose's Concentrated Manure for Corn and Potatoes, . . . . .	10.82	3.16	2.88-3.5	3.33	5.80	5.12	14.25	-	9.13	6-8	7.26	7.5-9.5	
127	Fine-ground Dry Fish, . . . . .	9.60	8.20	8-10	0.59	4.56	2.17	7.32	7-8	5.15	-	-	-	
<i>Chemicals.</i>														
72	Sulphate of Ammonia, . . . . .	2.00	20.40	19.76-21.42	-	-	-	-	-	-	-	-	-*	
73	Sulphate of Potash, . . . . .	5.94	-	-	-	-	-	-	-	-	-	24.80	-†	
74	Muriate of Potash, . . . . .	2.50	-	-	-	-	-	-	-	-	-	48.56	-	
86	Muriate of Potash, . . . . .	3.50	-	-	-	-	-	-	-	-	-	50.12	48-55	
124	Sulphate of Potash, . . . . .	6.27	-	-	-	-	-	-	-	-	-	24.52	24-26*	
125	Nitrate of Soda, . . . . .	1.74	15.10	14.82-15.64	-	-	-	-	-	-	-	-	-	
												MECHANICAL ANALYSES.		
												Time	Per cent.	Per cent.
												Per cent.	Per cent.	Per cent.

4. *Analyses of Commercial Fertilizers, etc. — Continued.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at—
21	Tobacco and Sulphur Lawn Fertilizer,	F. C. Sturtevant, Hartford, Conn.,	Springfield.
32	Potato, Hop and Tobacco Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Lee.
35	X.L. Superphosphate of Lime,	Bradley Fertilizer Company, Boston, Mass.,	North Adams.
40	Darling's Animal Fertilizer,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	North Framingham.
42	Ammoniated Wheat and Corn Manure,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Framingham.
47	The Ames Fertilizer,	Ames Fertilizer Company, Peabody, Mass.,	North Sudbury.
48	The N. Ward Company's High-grade Animal Fertilizer,	The N. Ward Company, Boston, Mass.,	Boston.
49	Red Star Brand 203 Fertilizer for General Crops,	Le Page Company, Boston, Mass.,	Woburn.
56	The Lawrence Fertilizer,	A. Lee & Co., Lawrence, Mass.,	Lawrence.
60	Lister's Success Fertilizer,	Lister Agricultural and Chemical Works, Newark, N. J.,	Lowell.
83	Cumberland Seeding-down Fertilizer,	Cumberland Bone Company, Portland, Me.,	Jefferson's.
97	Clark's Cove King Philip Alkaline Guano,	John S. Reese & Co., Baltimore, Md., Licensees,	New Bedford.
98	Clark's Cove Great Planet A. A. Manure,	John S. Reese & Co., Baltimore, Md., Licensees,	Taunton.
105	Standard Fertilizer,	Standard Fertilizer Company, Boston, Mass.,	Taunton.
106	Potato Fertilizer,	E. Frank Coe, New York City, N. Y.,	Sunderland.
113	Cumberland Superphosphate,	Cumberland Bone Company, Portland, Me.,	Northampton.
128	Fish and Potash, Anchor Brand,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
130	Dry Fish Guano,	Bradley Fertilizer Company, Boston, Mass.,	Cambridgeport.
137	Nitrogenous Superphosphate,	J. C. Dow & Co., Boston, Mass.,	Berlin.
144	Soluble Pacific Guano,	W. D. Stewart & Co., Boston, Mass.,	Barre Plains.
147	Special Favorite,	Davidge Fertilizer Company, New York City, N. Y.,	

## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.				TOTAL.		AVAILABLE.		POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaran- teed.	Found.	Guaran- teed.	Found.	Guaran- teed.	Found.
21	Tobacco and Sulphur Lawn Fertilizer, . . .	22.06	1.96	2.38	7.65	1.74	—	0.71	0.75	—	—	9.39	7.80	7.66
32	Potato, Hop and Tobacco Phosphate, . . .	14.23	2.08	2-3	7.14	2.46	1.79	11.17	11-15	—	10-13	9.39	4.24	3.5-4.5
35	XL Superphosphate of Lime, . . .	13.87	2.66	2.5-3	4.03	3.69	4.66	11.39	11-14	—	9-11	9.60	1.91	2-3
40	Darling's Animal Fertilizer, . . .	12.33	2.83	3.3-4.94	8.47	2.23	0.61	12.38	—	7.72	10-12	7.72	5.87	4-6
42	Ammoniated Wheat and Corn Manure, . . .	15.61	2.02	2-3	6.05	4.53	0.42	11.31	11-15	10.70	10-13	10.70	1.80	1.75-2.93
47	The Ames Fertilizer, . . .	21.22	3.12	2.47-3.3	5.40	5.64	1.14	10.00	8-12	9.58	7-10	9.58	1.04	0.75-2
48	N. Ward & Co.'s High-grade Animal Fertilizer, . . .	18.25	3.29	2.88-3.7	5.40	5.64	1.14	12.18	—	11.04	12-14	11.04	4.76	4-5
49	Red Star Brand 203 Fertilizer for General Crops, . . .	13.65	3.30	3-4	4.44	2.61	2.14	9.19	10-12	7.05	8-10	7.05	4.20	3-4
56	The Lawrence Fertilizer, . . .	14.06	2.32	2.06-2.88	6.45	6.42	2.56	15.43	—	12.87	10-12	12.87	1.94	2-3
60	Lister's Success Fertilizer, . . .	11.99	1.52	1.03-1.65	8.11	1.64	2.25	11.90	—	9.65	10.5-12	9.65	1.69	1.5-2
83	Cumberland Seeding-down Fertilizer, . . .	13.89	1.62	1.65	2.35	6.20	6.69	18.14	18-20	8.53	6-9	8.53	1.05	1
97	Clark's Cove King Philip Alkaline Guano, . . .	12.30	1.70	1.24-1.65	5.20	3.04	2.20	10.44	—	8.24	6.5-8	8.24	3.42	3-4
98	Clark's Cove Great Planet A. A. Manure, . . .	10.21	3.22	2.88-3.71	4.89	2.24	2.67	9.80	—	7.13	6-8	7.13	7.85	7.5-9.5
105	Standard Fertilizer, . . .	13.83	2.66	2-3	7.79	1.63	1.54	10.96	10-15	9.42	8-12	9.42	2.09	2-3
106	Potato Fertilizer, . . .	12.35	2.16	2-2.5	6.75	2.89	1.46	11.10	—	9.61	8-11	9.61	6.89	6
115	Cumberland Superphosphate, . . .	14.28	2.20	2-3	5.01	2.28	8.09	15.38	12-14	7.29	9-13	7.29	2.24	2-3
128	Fish and Potash, Anchor Brand, . . .	18.74	3.72	3.25-4.25	4.22	1.44	1.43	7.09	—	5.63	3-5	5.63	4.30	3-5
130	Dry Fish Guano, . . .	12.38	8.48	8.23-9.83	0.08	3.56	4.07	7.70	6-8	3.63	—	3.63	—	—
137	Nitrogenous Superphosphate, . . .	15.84	2.48	2.06-2.88	5.32	4.41	2.17	11.90	—	9.73	8-10	9.73	3.17	3-4
146	Soluble Pacific Guano, . . .	17.28	2.60	2.25-3	7.93	1.86	2.56	12.38	10.5-16	9.82	8.5-11	9.82	2.42	2-3
147	Special Favorite, . . .	18.38	1.64	1.24-2.06	9.96	1.40	0.03	11.41	11-14	11.38	10-12	11.38	1.82	1.5-2.5

## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at—
29	Farmer's Friend Superphosphate.	Read Fertilizer Company, New York, N. Y.,	Lee.
30	Ammoniated Bone Superphosphate.	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Lee.
45	Chittenden's Potato Manure.	National Fertilizer Company, Bridgeport, Conn.,	Northborough.
49	Red Star Brand 203 Fertilizer for General Crops.	Le Page Company, Boston, Mass.,	Woburn.
52	Cleveland Potato Phosphate.	Cleveland Dryer Company, Cleveland, Ohio,	South Framingham.
64	Mapes' Complete Manure for General Use.	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Lowell.
90	Quinnipiac Phosphate.	The Quinnipiac Company, New London, Conn.,	Fall River.
119	Fish and Potash.	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
132	Tobacco Manure, Wrapper Brand.	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Northampton.
138	LXL Ammoniated Bone Superphosphate.	The Milles Fertilizer and Oil Company, Milford, Conn.,	Northampton.
151	Soluble Bone Phosphate.	Davidge Fertilizer Company, New York, N. Y.,	Williamburg.
<i>Bones.</i>			
20	Ground Bone.	H. J. Baker & Bro., New York, N. Y.,	Springfield.
55	Royal Pure Ground Bone.	A. Lee & Co., Lawrence, Mass.,	Lawrence.
59	Chittenden's Ground Bone.	National Fertilizer Company, Bridgeport, Conn.,	Lowell.
61	Lister's Celebrated Bone.	Lister Agricultural and Chemical Works, Newark, N. J.,	Lowell.
71	Quinnipiac Pure Bone Meal.	The Quinnipiac Company, New London, Conn.,	Northampton.
78	Bowker's Fine ground Bone.	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
89	Haygrave's Bone.	Hargrave Manufacturing Company, Fall River, Mass.,	Fall River.
111	Ground Bone.	Edmund Hersey, Hingham, Mass.,	Hingham.
138	Fine-ground Bone.	J. C. Dow & Co., Boston, Mass.,	Cambridgeport.
141	Pure Ground Bone.	Wm. Lavery, Amesbury, Mass.,	Amesbury.





## 4. Analyses of Commercial Fertilizers, etc. — Continued.

9 Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	<i>Compound Fertilizers.</i>		
9	Lawn Dressing, . . . . .	H. J. Baker & Bro., New York, N. Y.,	Boston.
10	A. A. Ammoniated Superphosphate, . . . . .	H. J. Baker & Bro., New York, N. Y.,	Boston.
11	Square Brand Bone and Potash, . . . . .	Bowker Fertilizer Company, Boston, Mass.,	North Sudbury.
12	Ammoniated Bone Fertilizer, . . . . .	Bowker Fertilizer Company, Boston, Mass.,	North Sudbury.
13	Stockbridge's Manure for Asparagus, . . . . .	Bowker Fertilizer Company, Boston, Mass.,	North Sudbury.
15	Stockbridge's Manure for Vegetables and Potatoes, . . . . .	Bowker Fertilizer Company, Boston, Mass.,	Lee.
28	Lion Brand, . . . . .	Read Fertilizer Company, New York, N. Y.,	Frammingham.
38	Grass and Grain Fertilizer, . . . . .	Great Eastern Fertilizer Company, Rutland, Vt.,	Woburn.
50	Mayo's Superphosphate, . . . . .	C. E. Mayo & Co., Boston, Mass.,	Boston.
53	Breck's Lawn Dressing, . . . . .	Bowker Fertilizer Company, Boston, Mass.,	Lawrence.
63	Cliftenden's Universal Phosphate, . . . . .	National Fertilizer Company, Bridgeport, Conn.,	Lowell.
66	Mapes' Grass and Grain Spring Top-dressing, . . . . .	Mapes' Formula and Peruvian Guano Company, New York, N. Y.,	Amherst.
68	Wilcox Prepared Fertilizer, . . . . .	Leander Wilcox, Mystic Bridge, Conn.,	Amherst.
69	Wilcox Fish and Potash, . . . . .	Leander Wilcox, Mystic Bridge, Conn.,	Northampton.
75	Quinnipiac Fish and Potash, . . . . .	The Quinnipiac Company, New London, Conn.,	Northampton.
79	Bowker's Square Brand Fish and Potash, . . . . .	Bowker Fertilizer Company, Boston, Mass.,	Worcester.
84	Jefford's Animal Fertilizer with Potash, . . . . .	J. G. Jeffords, Worcester, Mass.,	Worcester.
85	Bartlett's Animal Fertilizer with Potash, . . . . .	C. A. Bartlett, Worcester, Mass.,	Worcester.
99	Clark's Cove Fish and Potash, . . . . .	John S. Reese & Co., Baltimore, Md.,	New Bedford.
100	Clark's Cove New England Favorite, . . . . .	John S. Reese & Co., Baltimore, Md.,	New Bedford.
102	Red Star Brand Special for Potatoes, . . . . .	Le Page Company, Boston, Mass.,	New Bedford.

## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.						POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	TOTAL.		AVAILABLE.	Found.	Guaranteed.
								Found.	Guaranteed.			
9	Lawn Dressing.	18.87	4.16	3.50	4.66	1.75	0.38	6.79	—	6.41	6.81	4.75
10	A. A. Ammoniated Superphosphate.	14.55	2.63	2.47—3.30	10.08	0.82	0.14	11.04	—	10.90	2.38	10—12
11	Square Brand Bone and Potash.	6.00	1.56	1.03—2.47	0.92	5.78	7.19	13.89	—	6.70	1.96	12—15
12	Ammoniated Bone Fertilizer.	12.85	2.21	2—3	2.72	3.95	5.73	12.40	10—12	6.67	2.43	8—10
13	Stockbridge's Manure for Asparagus.	11.94	3.54	3.25—4.25	2.93	2.48	4.73	10.14	8—10	6.41	5.06	7—8
15	Stockbridge's Manure for Vegetables and Potatoes.	10.97	4.12	3.25—4.25	2.87	4.72	4.68	12.17	8—10	7.59	5.23	7—8
28	Lion Brand.	14.16	1.12	0.82—1.65	5.86	3.33	1.91	11.10	10—12	9.19	4.23	8—10
38	Grass and Grain Fertilizer.	13.61	3.19	2.88—3.71	6.42	1.67	2.12	10.21	9—15	8.09	1.73	8—12
50	Mayo's Superphosphate.	17.11	2.50	2.05—2.85	8.15	0.85	1.23	10.23	10—14	9.00	2.46	9—12
53	Breck's Lawn Dressing.	9.41	3.84	4.12—4.94	2.20	3.09	6.97	12.26	—	5.29	5.03	5—6
63	Chittenden's Universal Phosphate.	15.15	2.65	2.06—2.88	4.95	3.62	2.67	11.14	11—12	8.67	3.19	2—3
66	Mapes Grass and Grain Spring Top-dressing.	12.00	4.16	4.12—5.77	3.35	3.80	2.60	9.75	7—9	7.15	5.44	5—7
68	Wilcox Prepared Fertilizer.	21.76	3.51	3.30—4.12	3.38	2.07	1.51	6.96	—	5.43	3.65	5.5—7.5
69	Wilcox Fish and Potash.	21.40	3.86	3.5—4.5	2.82	2.46	1.25	6.53	5—7	6.28	4.02	4—6
75	Quinnipiac Fish and Potash.	21.24	3.37	3.25—4.25	2.17	2.82	1.71	6.70	—	4.99	4.16	3—5
79	Bowler's Square Brand Fish and Potash.	14.50	2.64	2.25—3.25	3.74	2.75	2.87	9.36	8—10	6.49	4.01	4—6
84	Jefford's Animal Fertilizer with Potash.	4.93	3.60	4.12—5.77	0.13	12.05	5.78	17.96	11—16	12.18	5.07	5—7

## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at—
	<i>Compound Fertilizers.</i>		
107	High-grade Ammoniated Bone Superphosphate,	E. Frank Coe, New York, N. Y.,	Taunton.
108	Standard Ground Bone and Potash,	B. Randall, 113 Central St., Boston, Mass.,	Boston.
112	Potato Fertilizer,	H. S. Miller & Co., Newark, N. J.,	Sunderland.
113	Standard Superphosphate,	H. S. Miller & Co., Newark, N. J.,	South Deerfield.
116	Onion, Potato and Tobacco Manure,	The Quinnipiac Company, New London, Conn.,	South Deerfield.
117	Pegnot Fish and Potash,	The Quinnipiac Company, New London, Conn.,	South Deerfield.
118	Potato Manure,	The Quinnipiac Company, New London, Conn.,	Holyoke.
120	Phelps' Phosphate,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
121	Phelps' Complete Manure for Top-dressing,	Prentiss, Brooks & Co., Holyoke, Mass.,	Northampton.
129	Complete Manure for Top-dressing Grass and Grain,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
131	Fish and Potash, "A" Brand,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
133	Grass and Grain Spring Top-dressing,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Stoughton.
135	Fish and Potash, "D" Brand,	Joseph Church & Co., Tiverton, R. I.,	Boston.
136	Imperial Bone Superphosphate,	J. A. Tucker & Co., Boston, Mass.,	Cambridgeport.
139	Ground Bone Fertilizer,	J. C. Dow & Co., Boston, Mass.,	Ipswich.
140	Standard Superphosphate,	Standard Fertilizer Company, Boston, Mass.,	Amesbury.
142	Lavery's Superphosphate,	Wm. Lavery, Amesbury, Mass.,	Clinton.
143	Ammoniated Dissolved Bone Phosphate,	H. S. Miller & Co., Newark, N. J.,	Clinton.
144	Harvest Queen Phosphate,	H. S. Miller & Co., Newark, N. J.,	Clinton.
145	Vegetable Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Clinton.
149	Fish and Potash,	The Miles Fertilizer and Oil Company, Milford, Conn.,	Northampton.

## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.						POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaran- teed.	AVAILABLE.	Found.	Guaran- teed.
107	Compound Fertilizers.											
108	High-grade Ammoniated Bone Superphosphate.	13.46	2.24	2-2.5	7.92	2.29	2.11	12.32	11-15	10.21	1.78	9-12
109	Standard Ground Bone and Potash.	10.18	2.64	1.6-2.5	0.95	7.89	7.79	16.63	13-16	8.44	1.88	6-7
110	Potato Fertilizer.	9.77	4.86	3.71-4.12	3.96	2.86	0.91	7.45	8.5-10	6.53	7.88	8-11
111	Standard Superphosphate.	16.74	2.80	2.35-2.68	9.30	1.06	0.40	10.76	11.5-14.5	10.36	1.52	10-12
112	Onion, Potato and Tobacco Manure.	16.05	2.86	2.35-4.25	2.39	7.04	1.62	11.05	9-14	9.43	6.32	8-11
117	Piquet Fish and Potash.	9.50	2.86	2.5-3.25	0.20	4.23	3.67	8.15	-	4.48	6.35	3-5
118	Potato Manure.	14.04	3.67	2.5-3.25	1.71	4.87	3.11	9.79	6-11	6.03	5.81	4-6
120	Phelps' Phosphate.	15.51	2.73	2.47-3.30	10.26	0.69	0.33	11.23	10-12	10.95	3.02	3-4
121	Phelps' Complete Manure for Top-dressing.	9.83	6.63	4.12-4.94	5.23	2.46	0.32	8.01	7-8	7.69	8.27	8-10
122	Complete Manure for Top-dressing Grass and Grain.	10.29	4.94	4.64-5.77	3.53	3.02	0.26	6.81	-	6.53	3.13	2.5-3.5
131	Fish and Potash, "A" Brand.	23.34	2.86	2-3	3.94	2.60	0.96	7.50	-	6.54	3.91	4-6
133	Grass and Grain Spring Top-dressing.	10.93	5.02	4.12-5.77	3.93	2.00	2.56	9.15	7-9	6.59	6.28	6-7
135	Fish and Potash, "D" Brand.	18.59	3.36	3.30-4.12	1.05	2.92	1.66	5.63	5-6	3.97	4.62	3-4
136	Imperial Bone Superphosphate.	18.48	2.50	2.06-2.47	0.86	6.60	3.89	10.35	9-10	6.46	2.45	2.5-3
139	Ground Bone Fertilizer.	6.65	1.73	1.65-2.47	0.43	6.62	16.11	22.16	18-22	6.05	2.98	3-4
140	Standard Superphosphate.	12.03	2.32	2.3-3.5	9.80	2.02	1.19	12.01	11-16	10.82	1.83	9-13
142	Lavery's Superphosphate.	11.86	2.04	1.97	2.28	4.39	5.71	12.38	10.17	6.67	7.03	8-10
143	Ammoniated Dissolved Bone Phosphate.	11.50	1.82	1.65-2.06	7.57	2.18	0.46	10.21	9.5-12.5	9.75	1.90	1.5-2
144	Harvest Queen Phosphate.	6.22	1.04	0.89-1.05	3.10	8.11	1.25	12.46	10-12	11.21	1.83	1.5-2
145	Vacatable Bone Superphosphate.	13.24	5.80	4.94-5.77	4.20	3.82	0.42	8.44	9-7	8.02	6.10	6-7

## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	<i>Compound Fertilizers.</i>		
22	Lawn and Garden Dressing,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
23	Stockbridge's Manure for Top-dressing,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
34	Original Coe's Superphosphate of Lime,	Bradley Fertilizer Company, Boston, Mass.,	Lee.
43	Special Potato Manure,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Framingham
62	Darling's Fertilizer for Lawn and Gardens,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Lowell.
65	Mapes' Fruit and Vine Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Lowell.
70	Ammoniated Dissolved Bone,	Quinnipiac Company, New London, Conn.,	Northampton.
80	Stockbridge's Manure for Onions,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
88	Potato Phosphate,	Williams & Clark Co., New York, N. Y.,	Worcester.
91	Quinnipiac Market Garden Manure,	The Quinnipiac Company, New London, Conn.,	Fall River.
92	Brightman's Fish and Potash,	W. J. Brightman & Co., Tiverton, R. I.,	Fall River.
94	Complete Grass Manure,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
101	Clark's Cove Pilgrim Fertilizer,	John S. Reese & Co., Baltimore, Md., Licensees,	New Bedford.
109	Market Garden Fertilizer,	B. Randall, Boston, Mass.,	Boston.
114	Tobacco Fertilizer,	H. S. Miller & Co., Newark, N. J.,	South Deerfield.
122	Phelps' Complete Manure for Corn,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
123	Phelps' Complete Manure for Potatoes,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
130	Special Favorite,	Davidge Fertilizer Company, New York, N. Y.,	Williamsburg.

## 4. Analyses of Commercial Fertilizers, etc. — Concluded.

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.				PHOSPHORIC ACID IN ONE HUNDRED POUNDS.				POTASSIUM OXIDE IN ONE HUNDRED POUNDS.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	TOTAL.		Found.	Guaran- teed.	Found.	Guaran- teed.	Found.
								Found.	Guaran- teed.					
22	<i>Compound Fertilizers.</i>	10.35	4.29	4-5	3.44	2.70	3.98	10.12	-	6.14	5-6	4.46	5-6	4.46
23	Lawn and Garden Dressing, . . .	6.20	4.56	6-6	3.25	3.68	3.68	12.33	-	6.93	6-7	4.76	6-6	4.76
34	Stockbridge's Manure for Top-dressing, . .	14.89	2.34	2.05-2.85	8.84	1.36	1.66	11.86	10-14	10.20	8-11	1.87	1-2	1.87
43	Original Coe's Superphosphate of Lime, . .	21.07	3.18	3.7-4.5	6.48	1.97	2.09	9.64	7-10	7.45	6-8	4.86	5-6	4.86
65	Special Potato Manure, . . .	16.40	4.22	4-6	3.24	6.82	1.94	12.00	10-12	10.06	-	5.99	5-6	5.99
65	Darling's Fertilizer for Lawn and Gardens, .	14.10	2.30	1.85-2.47	7.11	0.86	0.51	7.98	7-9	7.47	-	12.22	11-12	12.22
70	Mapes' Fruit and Vine Manure, . . .	14.69	1.94	1.65-2.47	3.52	6.24	1.70	11.46	11-14	9.76	9-12	2.54	4-6	2.54
80	Ammoniated Dissolved Bone, . . .	18.87	3.05	3.25-4.25	5.53	3.06	1.15	10.03	8-10	8.88	7-8	4.58	6-6	4.58
88	Stockbridge's Manure for Onions, . . .	11.28	2.52	2-3	5.89	2.64	1.88	10.41	-	8.53	6-8	6.12	6-8	6.12
91	Potato Phosphate, . . .	16.07	3.68	3.25-4.25	3.09	6.80	1.19	10.88	-	9.39	8-11	6.34	7-8	6.34
92	Quinupiac Market Garden Manure, . . .	20.91	3.80	2.47-4.12	1.79	2.84	1.30	6.63	6-7	4.33	2-3	3.67	2-3	3.67
94	Brightman's Fish and Potash, . . .	18.70	3.20	3.71	4.52	1.60	0.28	6.70	-	6.42	5	8.35	7	8.35
101	Complete Grass Manure, . . .	17.56	1.36	1.03-2.68	5.63	1.96	1.97	9.45	-	7.48	6.5-7.5	3.11	2.5-3.5	3.11
109	Clark's Cove Pilgrim Fertilizer, . . .	17.89	3.78	1.65-2.47	4.41	5.52	0.29	10.22	10-16	9.93	8-10	2.97	2-4	2.97
114	Market Garden Fertilizer, . . .	19.94	5.90	5.25	0.38	0.75	1.13	9.24	-	1.11	3-4	7.89	5	7.89
114	Tobacco Fertilizer, . . .	19.94	5.90	5.25	0.38	0.75	1.13	9.24	-	1.11	3-4	7.89	5	7.89

*Agricultural Chemicals.*

*Muriate of Potash.*

and II. sent on from Amherst, Mass.; III. sent on from Concord, Mass.; IV. and V. sent on from Eastham, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . . .	0.43	1.90	0.64	2.97	2.10
Potassium oxide, . . .	50.97	49.20	49.68	47.24	49.20
Chlorine, . . .	48.64	53.00	50.00	38.83	44.85
Insoluble matter, . . .	0.11	0.11	Trace.	0.54	0.42

and II., sulphate of potash and magnesia, sent on from Amherst, Mass.; III., sulphate of potash, sent on from Eastham; IV., sulphate of potash, sent on from Feeding Hills.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C., . . .	14.70	17.35	8.26	2.54
Magnesium oxide, . . .	6.97	7.02	—	10.88
Potassium oxide, . . .	16.96	29.48	26.60	24.90
Phosphoric acid, . . .	32.97	40.68	41.96	48.32
Insoluble matter, . . .	2.70	1.47	0.51	2.67

*Nitrate of Soda.*

and II. sent on from Amherst; III. sent on from Eastham; IV. sent on from Concord.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C., . . .	1.74	1.50	6.62	1.30
Sodium oxide, . . .	38.14	33.63	44.96	—
Nitrogen, . . .	14.44	15.46	14.92	15.48
Insoluble matter, . . .	Trace.	0.10	None.	Trace.



*Agricultural Chemicals — Concluded.**Sulphate of Ammonia.*

[Two samples from Amherst.]

Moisture at 100° C., . . . . .	2
Nitrogen, . . . . .	20
Sulphuric acid, . . . . .	60
Insoluble matter, . . . . .	0

5. *Analyses of Commercial Fertilizers and  
Substances sent on for Examination.*

*Wood Ashes.*

[I, II. and III. sent on by Geo. A. Tapley, Revere, Mass.;  
Coolidge Bros., South Sudbury, Mass.]

	PER CENT	
	I.	II.
Moisture at 100° C, . . . . .	18.74	12.25
Calcium oxide, . . . . .	28.24	5.08
Magnesium oxide, . . . . .	4.64	0.27
Ferric oxide, . . . . .	1.10	12.36
Potassium oxide, . . . . .	5.94	2.24
Phosphoric acid, . . . . .	2.11	0.46
Insoluble matter (before calcination),.	10.52	58.45
Insoluble matter (after calcination), .	8.31	55.19

5. *Analyses, etc.*—Continued.*Wood Ashes (Four Samples).*

[Sent on by Coolidge Bros., South Sudbury, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C., . . . .	1.59	1.88	1.66	1.98
Calcium oxide, . . . .	41.60	39.89	43.09	40.39
Magnesium oxide, . . . .	3.00	4.41	2.33	3.85
Iron oxide, . . . .	0.84	1.07	0.69	0.97
Potassium oxide, . . . .	6.96	6.08	5.44	5.18
Phosphoric acid, . . . .	1.23	2.06	1.17	1.71
Insoluble matter (before calcination), .	11.65	15.87	9.03	12.17
Insoluble matter (after calcination), .	11.07	12.96	7.91	10.26

*Wood Ashes.*

I. sent on by H. G. Herrick, Lawrence, Mass.; II. sent on by James Logan, Worcester, Mass.; III. sent on by Frank Wheeler, Concord, Mass.; IV. sent on by Anson Wheeler, Concord, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C., . . . .	9.12	0.18	15.60	18.51
Calcium oxide, . . . .	31.63	39.39	32.86	31.07
Magnesium oxide, . . . .	3.34	3.12	3.81	2.69
Iron oxide, . . . .	1.07	—	—	—
Potassium oxide, . . . .	5.88	7.28	5.11	5.84
Phosphoric acid, . . . .	2.97	2.10	1.48	2.00
Insoluble matter (before calcination), .	18.79	12.80	16.59	8.67
Insoluble matter (after calcination), .	12.67	11.94	15.68	6.52

5. *Analyses, etc.* — Continued.*Wood Ashes*

[I. from Experiment Station, Amherst, Mass.; II. sent on by C. Worcester, Mass.; III. sent on by L. F. Priest, Rock Bottom, Mass. on by H. F. Cross, Hingham, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . .	15.07	0.42	15.07
Calcium oxide, . . . .	31.09	28.34	34.09
Magnesium oxide, . . . .	3.34	2.99	3.34
Ferric oxide, . . . .	-	-	-
Potassium oxide, . . . .	5.29	8.72	4.29
Phosphoric acid, . . . .	1.37	0.71	1.37
Insoluble matter (before calcination), .	13.20	52.73	12.20
Insoluble matter (after calcination), .	10.22	27.73	11.22

*Wood Ashes.*

[I. and II. sent on by W. L. Hubbard, Sunderland, Mass.; III. sent on by Faxon, Quincy, Mass.; IV. sent on by F. H. Williams, Sunderland, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . .	22.29	20.91	4.29
Calcium oxide, . . . .	32.32	29.97	32.32
Magnesium oxide, . . . .	3.14	3.04	4.29
Ferric oxide, . . . .	1.05	1.24	1.05
Potassium oxide, . . . .	4.27	5.64	6.27
Phosphoric acid, . . . .	1.47	1.32	1.47
Insoluble matter (before calcination), .	14.75	12.13	15.75
Insoluble matter (after calcination), .	11.52	10.33	13.52

5. *Analyses, etc.* — Continued.*Wood Ashes.*

and II. sent on by C. F. Clark, Granby, Mass.; III. sent on by L. B. Smith, Eastham, Mass.; IV. sent on by J. D. W. French, North Andover, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C., . . . .	15.37	13.17	14.08	14.52
Calcium oxide, . . . .	35.28	32.82	35.16	34.02
Magnesium oxide, . . . .	3.24	3.50	2.79	3.79
Iron oxide, . . . .	1.62	2.80	0.93	0.94
Potassium oxide, . . . .	7.73	6.86	4.16	5.88
Phosphoric acid, . . . .	0.78	0.79	1.69	2.37
Insoluble matter (before calcination), .	7.56	11.10	13.57	11.49
Insoluble matter (after calcination), .	6.80	8.73	11.32	9.64

*Wood Ashes.*

sent on by F. F. O'Neill, North Sudbury, Mass.; II. sent on by Jonathan Ames, South Lincoln, Mass.; III. sent on by F. C. Davis, East Longmeadow, Mass.; IV. sent on by B. W. Brown Concord, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C., . . . .	12.88	2.31	21.39	12.70
Calcium oxide, . . . .	35.41	32.82	28.01	32.67
Magnesium oxide, . . . .	2.75	5.34	2.86	2.64
Iron oxide, . . . .	1.65	1.71	1.64	1.16
Potassium oxide, . . . .	6.17	6.53	4.60	5.22
Phosphoric acid, . . . .	1.83	2.29	2.21	1.40
Insoluble matter (before calcination), .	12.69	20.46	13.66	24.81
Insoluble matter (after calcination), .	11.60	16.20	12.37	17.41

### 5. Analyses, etc. — Continued.

### Wood Ashes.

[I. sent on by Elijah Bradstreet, Danvers, Mass.; II. sent on by Campello, Mass.; III. sent on by C. E. Adams, South Framingham; sent on by Thomas Roche, South Deerfield, Mass.]

	PER CENT	
	I.	II.
Moisture at 100° C., . . . .	12.33	10.24
Calcium oxide, . . . .	34.10	37.89
Magnesium oxide, . . . .	2.64	2.70
Ferric oxide, . . . .	0.98	0.85
Potassium oxide, . . . .	10.80	6.70
Phosphoric acid, . . . .	1.06	1.60
Insoluble matter (before calcination), .	20.04	9.84
Insoluble matter (after calcination), .	7.54	8.54

### *Cotton-hull Ashes.*

[Sent on by W. L. Boutwell, Leverett, Mass.]

Moisture at 100° C.,	.	.	.	.	.	.	.
Calcium oxide,	.	.	.	.	.	.	.
Magnesium oxide,	.	.	.	.	.	.	.
Potassium oxide,	.	.	.	.	.	.	.
Phosphoric acid,	.	.	.	.	.	.	.
Insoluble matter (before calcination),	.	.	.	.	.	.	.
Insoluble matter (after calcination),	.	.	.	.	.	.	.

5. *Analyses, etc.*—Continued.*Saltpetre Waste.*

I. sent on from the American Powder Mills, Acton, Mass.; II. sent on by Coolidge Bros., South Sudbury, Mass.; III. sent on by L. B. Smith, Barre, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	5.19	0.38	4.82
Calcium oxide, . . . . .	0.47	0.84	0.85
Magnesium oxide, . . . . .	0.27	0.05	0.25
Sodium oxide, . . . . .	36.82	49.37	50.07
Potassium oxide (4½ cents per pound), . .	15.04	2.55	1.55
Sulphuric acid, . . . . .	1.02	0.81	1.30
Chlorine, . . . . .	53.50	58.00	57.04
Nitrogen (17 cents per pound), . . . .	1.90	0.65	0.52
Insoluble matter, . . . . .	Trace.	Trace.	0.09
Valuation per ton, . . . . .	\$20 00	\$4 11	\$3 17

*Refuse from Glue Factory.*

[Sent on by Chas. A. Newhall, Lynn, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	43.06
Organic and volatile matter, . . . . .	71.02
Ash, . . . . .	28.98
Phosphoric acid, . . . . .	0.217
Nitrogen, . . . . .	7.82
Insoluble matter, . . . . .	18.65

5. *Analyses, etc.* — Continued.*Fish Chum.*

[Two samples, sent on by L. B. Smith, Eastham, Ma

Moisture at 100° C, . . . . .	1
Organic and volatile matter, . . . . .	8
Total phosphoric acid, . . . . .	6
Soluble phosphoric acid, . . . . .	6
Reverted phosphoric acid, . . . . .	3
Insoluble phosphoric acid, . . . . .	3
Nitrogen, . . . . .	3
Insoluble matter, . . . . .	

*Dry Ground Fish.*

[I. sent on by S. S. Dwight, Hatfield, Mass.; II. sent on by Hatfield, Mass.; III. sent on by Thaddeus Graves, Hatfield

	PER
	I.
Moisture at 100° C., . . . . .	9.65
Ash, . . . . .	22.40
Total phosphoric acid, . . . . .	6.88
Soluble phosphoric acid, . . . . .	0.49
Reverted phosphoric acid, . . . . .	3.06
Insoluble phosphoric acid, . . . . .	3.33
Nitrogen, . . . . .	9.50
Insoluble matter, . . . . .	1.92

5. *Analyses, etc.*—Continued.

*Blood, Meat and Bone.*

[Sent on by Isaac Madill, Lexington, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	7.87
Ash, . . . . .	20.63
Calcium oxide, . . . . .	10.33
Phosphoric acid, . . . . .	8.29
Nitrogen, . . . . .	5.84
Insoluble matter, . . . . .	0.48

*Ground Bone.*

I. sent on by E. H. Smith, Northborough, Mass.; II. sent on by the Hargrave Manufacturing Company, Fall River, Mass.; III. sent on by Anson Wheeler, Concord, Mass.; IV. sent on by A. W. Green, Carlton, Mass; V. sent on by L. B. Smith, Eastham, Mass.]

*Mechanical Analyses.*

	PER CENT.				
	I.	II.	III.	IV.	V.
Fine, smaller than $\frac{1}{80}$ inch, . . . . .	36.83	46.87	—	42.43	6.14
Fine medium, smaller than $\frac{1}{32}$ inch, . . . . .	36.86	37.23	—	28.43	25.39
Medium, smaller than $\frac{1}{12}$ inch, . . . . .	24.58	11.80	—	21.12	28.17
Coarser than $\frac{1}{12}$ inch, . . . . .	1.73	4.10	—	8.02	40.30
	100.00	100.00	—	100.00	100.00

*Chemical Analyses.*

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . . . . .	4.51	8.29	6.14	8.21	8.25
Ash, . . . . .	56.83	67.21	50.71	62.02	57.53
Total phosphoric acid, . . . . .	22.69	26.72	18.17	17.67	16.84
Soluble phosphoric acid, . . . . .	0.14	0.34	4.14	0.56	0.14
Reverted phosphoric acid, . . . . .	5.70	2.78	8.77	3.61	0.35
Insoluble phosphoric acid, . . . . .	16.85	23.60	5.26	13.50	16.35
Nitrogen, . . . . .	3.86	2.78	2.78	2.72	3.42
Insoluble matter, . . . . .	1.48	0.65	1.02	0.86	1.29



5. *Analyses, etc.* — Continued.*Bones boiled in Potash.*

[Sent on from South Framingham, Mass.]

Moisture at 100° C.,	.	.	.	.	.	.	.	.	.
Organic and volatile matter,	.	.	.	.	.	.	.	.	.
Total phosphoric acid,	.	.	.	.	.	.	.	.	.
Soluble phosphoric acid,	.	.	.	.	.	.	.	.	.
Reverted phosphoric acid,	.	.	.	.	.	.	.	.	.
Insoluble phosphoric acid,	.	.	.	.	.	.	.	.	.
Potassium oxide,	.	.	.	.	.	.	.	.	.
Nitrogen,	.	.	.	.	.	.	.	.	.
Insoluble matter,	.	.	.	.	.	.	.	.	.

*Starch Waste.*

[Sent on from Rubber Factory, Hudson, Mass.]

Moisture at 100° C.,	.	.	.	.	.	.	.	.	.
Ash,	.	.	.	.	.	.	.	.	.
Nitrogen,	.	.	.	.	.	.	.	.	.

*"Sludge" from Worcester Sewage Precipitating*

[Sent on by J. G. Jefferds, Worcester, Mass.]

	A Receiv
Moisture at 100° C.,	88.
Organic and volatile matter,	90.
Calcium oxide,	1.
Magnesium oxide,	0.
Ferrie and aluminic oxides,	6.
Potassium oxide,	0.
Phosphoric acid,	0.
Nitrogen,	0.
Insoluble,	0.
Valuation per ton,	\$0

5. *Analyses, etc.* — Continued.*Tankage.*

[Sent on by the Bowker Fertilizer Company, Boston, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	2.17
Total phosphoric acid, . . . . .	12.79
Available phosphoric acid, . . . . .	6.01
Insoluble phosphoric acid, . . . . .	6.78
Ether extract, . . . . .	19.19

*Florida Phosphate Rock.*

I, II. and III. sent on from Boston, Mass.; IV., V. and VI. sent on by Geo. Frost, Mandarin, Fla.; VII. sent on by M. D. Brooks, Fort Meade, Fla.]

NUMBER.	Moisture at 100° C.	Phosphoric Acid.	Calcium Oxide.	Ferric and Aluminic Oxides.	Insoluble Matter.
I., . . . . .	1.43	33.33	44.16	1.31	4.65
II., . . . . .	1.18	27.07	37.57	2.59	21.96
III., . . . . .	5.47	6.95	12.36	4.07	53.61
IV., . . . . .	1.23	18.40	17.14	6.17	54.74
V., . . . . .	1.06	27.42	28.08	7.43	34.00
VI., . . . . .	10.79	2.92	0.55	—	71.32
VII., . . . . .	13.62	22.42	28.06	9.46	23.30

*Phosphatic Fertilizers.*

I, plain superphosphate, sent on by Anson Wheeler, Concord, Mass.; II, dissolved bone-black, sent on by Anson Wheeler, Concord, Mass.; III, dissolved bone-black, sent on from Amherst, Mass.; IV., acid phosphate, sent on by L. B. Smith, Eastham, Mass.; V., German phosphatic slag, sent on from Amherst, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . . . . .	10.43	10.26	20.07	10.39	0.47
Total phosphoric acid, . . . . .	16.55	16.77	17.35	13.45	19.04
Soluble phosphoric acid, . . . . .	10.87	13.92	14.80	10.17	—
Inverted phosphoric acid, . . . . .	1.92	1.29	2.28	2.26	—
Insoluble phosphoric acid, . . . . .	3.76	1.56	0.27	1.02	—
Calcium oxide, . . . . .	Not determined.			—	46.47
Insoluble matter, . . . . .	7.42	4.28	2.13	10.39	4.39

### 5. Analyses, etc. — Continued.

### Hen Manure.

[Sent on by A. F. Hunter, South Natick, Mass.]

Moisture at 100° C.,	.	.	.	.	.	.	.
Ash,	.	.	.	.	.	.	.
Calcium oxide,	.	.	.	.	.	.	.
Magnesium oxide,	.	.	.	.	.	.	.
Potassium oxide,	.	.	.	.	.	.	.
Sulphuric acid ( $\text{SO}_3$ ),	.	.	.	.	.	.	.
Phosphoric acid,	.	.	.	.	.	.	.
Nitrogen,	.	.	.	.	.	.	.
Insoluble matter,	.	.	.	.	.	.	.

**Jute Waste.**

[Sent on by J. H. Easterbrook, Dudley, Mass.]

Moisture at 100° C.,	.	.	.	.	.	.	.
Potassium oxide (4½ cents per pound),	.	.	.	.	.	.	.
Phosphoric acid (6 cents per pound),	.	.	.	.	.	.	.
Nitrogen (10 cents per pound),	.	.	.	.	.	.	.
Valuation per ton,	.	.	.	.	.	.	.

*Shelled Corn, damaged by Fire and Water*

[Sent on by Chas. I. Pierce, West Northfield, Mass.]

Moisture at 100° C,	.	.	.	.	.	.	.	.
Dry matter,	.	.	.	.	.	.	.	.

### *Analysis of Dry Matter.*

Crude ash, . . . . .	1.0
" cellulose, . . . . .	1.0
" fat, . . . . .	1.0
" protein (nitrogenous matter), . . . . .	1.0
Non-nitrogenous extract matter, . . . . .	1.0

*Fertilizing Constituents of the Above.*

Moisture at 100° C.,	.	.	.	.	.	.	.	.
Ash,	.	.	.	.	.	.	.	.
Phosphoric acid,	.	.	.	.	.	.	.	.
Potassium oxide,	.	.	.	.	.	.	.	.
Nitrogen,	.	.	.	.	.	.	.	.
Insoluble matter,	.	.	.	.	.	.	.	.
Valuation per ton,,	.	.	.	.	.	.	.	.

5. *Analyses, etc.*—Continued.*Buckwheat Hulls.*

[Sent on by E. L. Smith, South Schodack, N. Y.]

	Per Cent.
Moisture at 100° C., . . . . .	11.900
Calcium oxide, . . . . .	0.247
Magnesium oxide, . . . . .	0.236
Iron oxide, . . . . .	0.020
Potassium oxide, . . . . .	0.521
Phosphoric acid, . . . . .	0.073
Nitrogen, . . . . .	0.490
Insoluble matter, . . . . .	0.066

*Sea Weed.*

[Sent on by D. C. Potter, Fairhaven, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	16.260
Calcium oxide, . . . . .	2.061
Magnesium oxide, . . . . .	1.175
Sodium oxide, . . . . .	3.529
Potassium oxide, . . . . .	0.785
Phosphoric acid, . . . . .	0.191
Nitrogen, . . . . .	4.250
Insoluble matter, . . . . .	5.525

*Residuum from Soft Coal.*

[Sent on by B. N. Farren, Montague City, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	2.63
Calcium oxide, . . . . .	1.38
Magnesium oxide, . . . . .	0.45
Iron oxide, . . . . .	6.02
Alumina, . . . . .	2.71
Potassium oxide, . . . . .	0.20
Phosphoric acid, . . . . .	0.47
Insoluble matter (before calcination), . . . . .	88.09
Insoluble matter (after calcination), . . . . .	72.38



5. *Analyses, etc.*—Concluded.*Compound Fertilizers.*

I. sent on by C. A. Bartlett, Worcester, Mass; II. sent on by Ebed L. Ripley, Hingham, Mass.; III. sent on by A. L. Ames, Peabody, Mass.; IV. and V. sent on by A. E. Belden, North Hadley, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . . .	3.54	4.41	10.70	14.29	9.26
ash, . . . . .	37.69	34.28	—	56.28	50.07
Total phosphoric acid, . .	14.12	14.70	10.55	12.04	7.39
Soluble phosphoric acid, . . .	1.41	0.58	5.69	7.27	5.27
Inverted phosphoric acid, .	7.46	6.84	3.66	3.41	0.24
Insoluble phosphoric acid, .	5.25	7.28	1.20	1.36	1.88
Potassium oxide, . . . .	0.07	0.46	0.96	4.39	7.30
Nitrogen, . . . . .	4.84	6.18	3.77	4.58	5.10
Insoluble matter, . . . .	0.55	0.49	1.29	0.72	0.82

*Compound Fertilizers.*

I. sent on by J. M. Butman, Lowell, Mass.; II. sent on by Joseph Breck & Sons, Boston, Mass.; III. sent on by A. F. Crocker, North Amherst, Mass.; IV. and V. sent on by L. B. Smith, Eastham, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . . .	8.99	11.01	9.16	11.51	15.81
ash, . . . . .	51.46	71.33	61.27	84.53	72.59
Total phosphoric acid, . .	14.57	8.47	14.89	0.67	10.23
Soluble phosphoric acid, . .	6.54	2.64	5.38	—	4.54
Inverted phosphoric acid, .	5.83	4.38	3.78	0.50	4.32
Insoluble phosphoric acid, .	2.20	1.45	5.73	0.17	1.37
Potassium oxide, . . . .	2.26	3.81	3.24	9.67	3.71
Nitrogen, . . . . .	3.07	3.88	2.30	4.30	1.84
Insoluble matter, . . . .	0.83	4.31	4.90	1.74	7.41

*Methods of Fertilizer Analysis.*

*Preparation of Sample.* — The entire available spread upon a smooth, hard surface, and intimately without grinding, all lumps being broken up with Unnecessary loss or gain of moisture is to be *Moisture:* dry 2 grams in the air-bath at 100 to 1 a constant weight.

1. *Total Phosphoric Acid.* — Weigh out 2 grams num crucible, and destroy the organic matter by burning in a muffle. Weigh when cool, to determine organic and volatile matter." Digest the crucible and with dilute hydrochloric acid, until the solution of is complete. Filter, and evaporate the filtrate to dryness. The "insoluble matter" on the filter is weighed. The residue left from the evaporation is with dilute nitric acid, if the molybdic method is allowed, but with hydrochloric acid if method (2) is The solution after filtering is made up to a volume cubic centimetres with distilled water.

(1) The molybdic method: 25 cubic centimetres solution are digested in a water-bath at 65° C. for two hours, with an excess of molybdic solution. precipitate is brought upon a filter, and washed with containing a little molybdic solution. It is then dissolved in ammonia water, the solution nearly neutralized with hydrochloric acid, and magnesia mixture added slowly, with constant stirring. The precipitate is allowed to stand for three hours, when it is filtered through a Gooch filter, washed with dilute ammonia, ignited and weighed.

(2) The following method is occasionally employed when phosphates of iron and alumina are present in small quantities only: To 50 cubic centimetres of the hydrochloric solution add ammonia in slight excess. After a few minutes, acidify with acetic acid, and filter off the phosphates of iron and alumina, washing carefully with water. To the filtrate add sufficient oxalate of ammonia to precipitate all the lime; digest for several hours at a temperature below boiling, and filter through double filters with

Previously been washed with oxalate of ammonia, washing thoroughly with water. Dissolve the phosphates of iron and alumina on the filter with warm dilute hydrochloric acid, and wash into a beaker containing a small quantity of powdered tartaric acid. When the latter has gone into solution, mix with the filtrate from the oxalate of ammonia. The phosphoric acid is precipitated with magnesia mixture, and treated as in (1).

**Soluble phosphoric acid:** Weigh out 2 grams into a beaker, cover with 10 to 15 cubic centimetres of water, and allow it to stand for fifteen minutes, stirring three times at equal intervals. Decant the solution through a filter into a graduated cylinder. Add another like quantity of water, and let it stand fifteen minutes more, stirring as before. Filter the solution into the cylinder, and wash the residue on the filter until the filtrate amounts to 200 cubic centimetres. The phosphoric acid is determined in an aliquot part of the solution as under total phosphoric acid.

**Insoluble phosphoric acid:** Add 100 cubic centimetres of neutral ammonia citrate (sp. gr. 1.09) to the beaker in which the digestion with water has been made. Put in a water-bath and heat to 65° C. Drop in the filter containing the residue from the above operation, and digest for thirty minutes, stirring every five minutes. Filter and wash thoroughly, using the suction pump. Dry, and burn. The ash is then treated as under total phosphoric acid.

**Reverted phosphoric acid:** The sum of the soluble and insoluble subtracted from the total gives the reverted or citrate-soluble phosphoric acid.

**Reagents:** The reagents used in the estimation of phosphoric acid are prepared according to directions given in the "Proceedings of the Association of Official Agricultural Chemists," 1889, pages 225 and 226.

For ammonium citrate, 370 grams of citric acid are dissolved in 1,500 cubic centimetres of water, nearly neutralized with crushed carbonate of ammonia, heated to expel carbonic acid, exactly neutralized with ammonia, and brought to a specific gravity of 1.09.

The molybdic solution is prepared by dissolving 100 grams of molybdic acid in 417 cubic centimetres of ammonia of



specific gravity .96. Pour this solution into 1,200 cubic centimetres of nitric acid of specific gravity 1.20, and keep in a warm place for several days, or until a portion heated to 40° C. deposits no yellow precipitate.

The magnesia mixture is prepared by dissolving 50 grams of crystallized magnesium chloride and 50 grams of ammonium chloride in 700 cubic centimetres of water of specific gravity .96, and bringing to a volume of 1,000 cubic centimetres.

2. *Methods of Determining Nitrogen.* — The methods of soda-lime and soda-ash recommended by the American Official Agricultural Chemists, in their "Proceedings," pages 218 to 221, are employed, with occasional exceptions, in analyses by the absolute cupric oxide mode.

3. *Method for Determining Potash.* — Weigh 100 grams of the material in a platinum crucible, and heat thoroughly at a temperature just below red heat for several hours with very dilute hydrochloric acid in a water-bath. Filter into a graduated cylinder, and dilute to 200 cubic centimetres. Take 50 cubic centimetres for each test. Warm, and add, in small quantities, an excess of barium hydrate. Digest for one or two hours at a temperature of 70 to 90° C., filter, washing carefully, and add to the filtrate a few drops of ammonium molybdate. Add enough ammonium carbonate to precipitate the barium hydrate. Filter, and bring the filtrate to a boil in the water-bath in a platinum dish. Heat carefully in a covered platinum dish at a temperature just below red heat until compounds of ammonia cease to come off. Wash the residue in water, filtering if necessary, and add an excess of platinum tetrachloride. Evaporate to dryness in the water-bath, add a small quantity of 80 per cent alcohol, and allow it to stand for a few hours. Filter into a Gooch crucible, washing with alcohol, dry, and ignite. Filter through paper, wash as before, dry, and ignite. Add potassium platonic chloride upon a weighed filter with a camel's-hair brush, and weigh. If very soluble double salt is washed with the strong solution of potassium chloride, saturated with potassium platonic chloride, as recommended in the "Proceedings of the American Official Agricultural Chemists," 1889, page 223.

6. *Miscellaneous Analyses.*  
(*Insecticides*).

*Paris Green.*

[Sent on from Amherst, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	1.34	1.31
Copper oxide, . . . . .	33.35	33.45
Benign oxide, . . . . .	61.25	61.21
Insoluble matter, . . . . .	0.13	0.09
Acetic acid, . . . . .	3.93	3.94
	100.00	100.00

*Sulphatine.*

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	1.40
Calcium oxide, . . . . .	18.60
Copper oxide, . . . . .	2.61
Phosphoric acid, . . . . .	4.73
Sulphur, . . . . .	48.28
Insoluble matter, . . . . .	1.63

*Death to Rose Bugs.*

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	2.95
Calcium, . . . . .	54.14
Calcium oxide, . . . . .	17.76
Copper oxide, . . . . .	1.05
Phosphoric acid, . . . . .	4.35
Sulphur, . . . . .	34.53
Insoluble matter, . . . . .	0.49

*Prof. De Graff's Bug Destroyer.*

Moisture at 100° C.,	.	.	.	.	.	.	.	.
Residue from evaporation,	.	.	.	.	.	.	.	.
Mercury,	.	.	.	.	.	.	.	.
Chlorine,	.	.	.	.	.	.	.	.
Sulphuric acid,	.	.	.	.	.	.	.	.
Aluminic oxide,	.	.	.	.	.	.	.	.
Potassium oxide,	.	.	.	.	.	.	.	.

[I. sent on by Franklin Crocker, Hyannis, Mass.; II. made at  
stems treated for two days with warm water gave 13.5 ou

Specific gravity, . . . . .	1.3
Moisture at 100° C., . . . . .	37
Ash, . . . . .	19
Nitrogen, total, . . . . .	2
Nitrogen as nitrates, . . . . .	0
Nicotine, . . . . .	2
Ferric and aluminic oxides, . . . . .	0
Calcium oxide, . . . . .	3
Magnesium oxide, . . . . .	2
Phosphoric acid, . . . . .	0
Sodium oxide, . . . . .	0
Potassium oxide, . . . . .	6
Insoluble matter, . . . . .	Tr

## II. ANALYSES OF WATER SENT ON FOR EXAMINATION.

[Parts per million.]

Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
.06	.120	3.00	32.00	24.00	1.95	-	Amherst.
.02	.140	6.00	90.00	58.00	2.60	None.	Amherst.
.02	.040	Trace.	44.00	20.00	.79	None.	Rutland.
None.	.03	52.00	194.00	70.00	3.51	None.	North Hadley.
.02	.03	14.00	170.00	90.00	8.14	None.	Southbridge.
.016	.070	32.00	224.00	84.00	2.60	None.	Amherst.
.60	.12	10.00	58.00	16.00	1.69	None.	Gilbertville.
.02	.04	16.00	162.00	76.00	3.25	None.	Northborough.
.02	.03	8.00	96.00	16.00	1.27	None.	Amherst.
.20	.04	12.00	92.00	48.00	1.95	None.	Gilbertville.
.18	.04	12.00	74.00	40.00	1.95	None.	Gilbertville.
.08	.12	24.00	130.00	62.00	3.51	-	Foxborough.
Trace.	.04	16.00	102.00	46.00	3.25	None.	Southbridge.
.20	.18	32.00	378.00	150.00	-	-	Amherst.
.01	.07	Trace.	82.00	14.00	.79	-	Westhampton.
.03	.14	Trace.	60.00	8.00	.63	None.	West Farms.
.16	.06	20.00	160.00	30.00	2.99	-	North Amherst.
.16	.32	6.00	134.00	36.00	1.27	-	South Gardner.
.25	.30	4.00	-	-	-	-	Amherst.
.08	.06	10.00	320.00	210.00	11.35	-	Rome, N. Y.
None.	.08	16.00	168.00	28.00	2.60	-	North Amherst.
.04	.20	18.00	178.00	98.00	3.77	None.	Amherst.
Trace.	.04	14.00	102.00	92.00	1.56	Present.	Amherst.
.02	.48	6.00	110.00	10.00	2.99	-	Northborough.
.06	.10	22.00	274.00	104.00	6.71	None.	South Deerfield.
Trace.	.04	10.00	160.00	40.00	2.86	-	Amherst.
.13	.12	8.00	144.00	44.00	1.43	None.	Ashby.
.03	.04	8.00	124.00	24.00	4.16	None.	Sunderland.
Trace.	.02	28.00	144.00	14.00	5.00	Present.	Amherst.

*Analyses of Water — Continued.*

Number.	Actual Ammonia.	Alkalimoid Ammonia.	Chloride.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	
30,	None.	.05	20.00	180.00	60.00	3.38	None.	Ro
31,	Trace.	.24	10.00	210.00	60.00	4.71	-	Su
32,	.24	15.36	12.00	64.00	20.00	1.95	-	Su
33,	.04	.20	8.00	110.00	14.00	2.08	-	An
34,	None.	.04	12.00	170.00	70.00	3.77	None.	An
35,	.01	.05	6.00	152.00	30.00	8.14	None.	So
36,	.72	.56	6.00	154.00	76.00	3.51	-	Li
37,	None.	.036	6.00	62.00	40.00	2.08	Present.	An
38,	.01	.135	34.00	202.00	100.00	2.73	-	Es
39,	.06	.628	10.00	124.00	98.00	3.25	-	An
40,	1.12	3.84	28.00	450.00	216.00	6.86	None.	An
41,	.04	.104	14.00	180.00	54.00	3.25	None.	An
42,	.072	.10	8.00	126.00	90.00	3.25	None.	Su
43,	.276	.172	4.00	60.00	38.00	2.60	-	No
44,	.128	.196	16.00	150.00	74.00	1.69	None.	W
45,	.104	.152	4.00	34.00	16.00	.32	Present.	W
46,	.10	.112	68.00	392.00	122.00	5.71	None.	W
47,	.084	.128	16.00	150.00	44.00	1.69	None.	W
48,	.08	.196	70.00	420.00	164.00	6.00	None.	Ac
49,	.068	.120	22.00	124.00	54.00	1.27	-	Gl
50,	.37	.21	12.00	58.00	28.00	1.95	None.	W
51,	.022	.068	20.00	204.00	120.00	3.90	None.	An
52,	1.55	.40	32.00	314.00	118.00	3.90	Present.	An
53,	.064	.176	60.00	352.00	158.00	3.51	Present.	An
54,	.140	.180	76.00	458.00	150.00	9.57	Present.	Ac
55,	.088	.080	12.00	92.00	78.00	1.95	None.	Ba
56,	.060	.044	16.00	156.00	56.00	2.60	None.	Ba
57,	.084	.092	Trace.	62.00	44.00	.48	None.	Br
58,	.076	.108	4.00	32.00	20.00	.32	None.	Br
59,	.100	.248	36.00	110.00	10.00	1.95	None.	Br

*Analyses of Water — Concluded.*

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
60,	.08	.226	14.00	106.00	40.00	2.47	None.	Leverett.
61,	Trace.	.016	Trace.	88.00	18.00	3.25	None.	Shutesbury.
62,	.062	.052	340.00	844.00	664.00	3.25	None.	Clifton.
63,	.188	.176	8.00	126.00	82.00	2.60	Present.	Bedford.
64,	.140	.180	32.00	560.00	460.00	6.71	None.	Bedford.
65,	.088	.116	24.00	320.00	220.00	3.64	None.	Bedford.

The analyses have been made according to Wanklyn's process, familiar to chemists, and are directed towards the indication of the presence of chlorine, free and albuminoid ammonia, and the poisonous metals, lead in particular. (For a more detailed description of this method, see "Water Analyses," by J. A. Wanklyn and E. T. Chapman.)

Mr. Wanklyn's interpretation of the results of his mode of investigation is as follows:—

1. Chlorine alone does not necessarily indicate the presence of filthy water.

2. Free and albuminoid ammonia in water, without chlorine, indicates a vegetable source of contamination.

3. More than five grains per gallon\* of chlorine (=71.4 parts per million), accompanied by more than .08 parts per million of free ammonia and more than .10 parts per million of albuminoid ammonia, is a clear indication that the water is contaminated with sewage, decaying animal matter, urine, etc., and should be condemned.

4. Eight-hundredths parts per million of free ammonia and one-tenth part per million of albuminoid ammonia render a water very suspicious, even without much chlorine.

\* One gallon equals 70,000 grains.

5. Albuminoid ammonia, over .15 parts per ought to absolutely condemn a water which contains

6. The total solids found in the water should not exceed forty grains per gallon (571.4 parts per million).

An examination of the previously stated results of indicate that Nos. 7, 10, 11, 14, 17, 18, 19, 23, 27, 36, 37, 40, 43, 44, 45, 46, 50, 52, 54, 59, 63 and to be condemned as unfit for family use, while Nos. 25, 33, 39, 42, 47, 48, 49, 53, 55, 56, 58, 60 and 63 considered suspicious. From this record it will be over one-third of the entire number of well waters proved unfit for drinking. Heating well waters to boiling point removes, not unfrequently, immediate Eight samples gave unmistakable evidence of the of lead.

Parties sending on water for analysis ought to be careful to use clean vessels, clean stoppers, etc. Samples should be sent on without delay after collection. One gallon is desirable for the analysis.

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COMPILATION OF ANALYSES MADE AT AMHERST, MASS., OF  
AGRICULTURAL CHEMICALS AND REFUSE MATERIALS  
USED FOR FERTILIZING PURPOSES.

PREPARED BY W. H. BEAL.

[As the basis of valuation changes from year to year, no valuation is stated.]

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1868-1891.

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This compilation does not include the analyses made of licensed fertilizers. They  
to be found in the reports of the State Inspector of Fertilizers from 1873 to 1890,  
ained in the reports of the Secretary of the Massachusetts State Board of Agri-  
ure for those years.

C. A. G.

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Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOS- PHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phos- phoric Acid.	Insoluble Phos- phoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Alumi- nic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
			Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
<i>I. Chemicals, Refuse Salts, Ashes, etc.</i>																						
Muriate of potash, . . . . .	54	2.00	-	-	-	58.98	45.94	51.80	-	-	-	-	-	-	6.69	-	.55	-	-	-	48.60	.75
Sulphate of potash, . . . . .	19	2.50	-	-	-	51.28	21.36	33.80	-	-	-	-	-	-	4.46	-	1.50	-	45.72	-	-	.75
Sulphate of potash and magnesia, . . . . .	15	4.75	-	-	-	29.48	16.96	23.50	-	-	-	-	-	-	6.25	2.57	-	44.25	-	2.60	1.41	
Kainite, . . . . .	4	3.20	-	-	-	16.48	12.51	13.54	-	-	-	-	-	-	18.97	1.15	9.80	-	20.55	33.25	2.13	
Carnallite, . . . . .	1	-	-	-	-	-	-	13.88	-	-	-	-	-	-	7.66	-	13.19	-	.56	41.56	-	
Krugite, . . . . .	1	4.82	-	-	-	-	-	8.42	-	-	-	-	-	-	5.57	12.45	8.79	-	31.94	6.63	14.96	
Sulphate of magnesia ( <i>Kieserite</i> ), . . . . .	9	22.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	36.10	-	6.73	
Nitrate of potash, . . . . .	2	1.93	14.58	11.60	13.09	45.62	44.76	46.19	-	-	-	-	-	-	-	-	-	-	-	-	-	
Nitrate of soda, . . . . .	19	1.40	16.01	14.44	15.75	-	-	-	-	-	-	-	-	-	35.25	-	-	-	-	.50	.50	
Sulphate of ammonia, . . . . .	24	1.00	21.68	19.70	20.50	-	-	-	-	-	-	-	-	-	-	-	-	-	60.00	-	-	
Saltpetre waste, . . . . .	10	2.75	3.30	.52	9.43	30.94	1.55	15.50	-	-	-	-	-	-	34.25	75	.19	-	1.85	-	48.30	



	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOSPHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
II. Guanos, Phosphates, etc. — Concluded.																							
	2	7.60	-	-	-	-	-	-	-	34.45	34.09	34.27	-	-	-	-	37.45	-	10.27	-	-	-	2.70
Navassa phosphate,												35.21	-	-	-	-	-	-	-	-	-	-	6.46
Brockville phosphate,	1	2.50	-	-	-	-	-	-	-	-	-	30.51	18.01	23.49	-	3.06	21.65	-	48.66	3.42	10.12	-	9.40
Phosphatic slag,	4	1.45	-	-	-	-	-	-	-	30.54	16.56	28.28	-	-	-	-	44.89	-	-	-	-	-	3.64
Bone-black,	5	4.60	-	-	-	-	-	-	-	-	-	35.88	-	-	-	-	-	-	-	-	-	-	4.50
South American bone-ash,	1	7.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III. Refuse Substances.																							
	14	12.50	6.37	13.55	8.10	10.52	-	-	-	6.23	1.53	1.91	-	-	-	-	-	-	-	-	-	-	-
Dried blood,												3.43	-	-	-	-	-	-	-	-	-	-	1.38
Ammonite,	1	5.88	-	-	-	11.33	-	-	-	-	-	.88	-	-	-	-	-	-	-	-	-	-	.96
Oleomargarine refuse,	1	8.54	14.42	-	-	12.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.44
Felt refuse,	1	29.24	33.53	-	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39.05
Sponge refuse,	1	7.25	-	-	-	2.43	-	-	-	-	-	3.19	-	-	-	-	3.94	1.27	-	-	-	-	.24
Horn and hoof waste,	3	10.17	7.63	15.49	11.84	13.25	-	-	-	2.30	1.36	1.83	-	-	-	-	-	-	-	-	-	-	3.63
Raw wool,	1	6.95	7.54	-	-	12.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.90
Wool waste,	5	9.27	-	10.20	1.18	5.64	3.08	.54	1.30	-	-	.29	-	-	-	-	.07	.07	-	-	-	-	-
Wool washings (water),	1	-	-	-	-	-	-	-	3.92	-	-	-	-	-	-	.49	.28	-	-	-	-	-	-

Wool washings (acid), .	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wool washings (alkaline), .	1	.02	.08	3.28	-	-	.09	-	-	-	-	-	-	-	-	-	-	-	-
Meat mass, .	5	12.09	13.60	11.50	9.60	10.44	-	-	-	-	-	-	-	-	-	-	-	-	-
Bone soup, .	1	82.92	7.07	-	-	1.14	-	-	-	-	-	-	-	-	-	-	-	-	-
Dried soup from meat and bone, .	1	14.80	8.40	-	-	9.97	-	-	-	-	-	-	-	-	-	-	-	-	-
Dried soup from rendering cattle feet, .	1	10.80	7.50	-	-	14.47	-	-	-	-	-	-	-	-	-	-	-	-	-
Dried soup from horse renderling, .	1	92.14	-	-	-	1.12	-	-	-	-	-	-	-	-	-	-	-	-	-
Soap-grease refuse, .	2	29.25	51.39	4.20	2.21	3.21	-	-	-	-	-	-	-	-	-	-	-	-	-
Bones, .	131	7.47	56.07	4.70	1.62	4.12	-	-	-	-	-	-	-	-	-	-	-	-	-
Tankage, .	13	13.20	28.75	8.07	4.00	6.82	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish with less than twenty per cent. water, .	55	12.75	21.50	11.40	6.81	7.25	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish with between twenty and forty per cent. water, .	9	29.34	19.14	7.41	4.22	5.81	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish with more than forty per cent. water, .	10	45.46	15.50	7.60	2.43	4.97	-	-	-	-	-	-	-	-	-	-	-	-	-
Whale meat, raw, .	1	44.50	1.04	-	-	4.68	-	-	-	-	-	-	-	-	-	-	-	-	-
Lobster shells, .	1	7.27	-	-	-	4.50	-	-	-	-	-	-	-	-	-	-	-	-	-
Custor-bean pomace, .	4	9.98	5.70	5.72	5.33	5.56	1.70	.64	1.12	2.22	1.57	2.16	-	-	-	-	-	-	-
Cotton-seed meal, .	10	7.75	5.77	7.26	4.02	6.66	2.09	.89	1.62	3.17	1.26	1.95	-	-	-	-	-	-	-
Rotten brewer's grain, .	1	78.77	-	-	-	.72	-	-	.04	-	-	.43	-	-	-	-	-	-	-
Tobacco stems, .	6	10.61	14.07	2.91	.90	2.29	8.82	3.76	6.44	2.09	.44	.60	-	-	-	-	-	-	-
Cotton waste, wet, .	1	34.69	-	-	-	1.30	-	-	.80	-	-	1.54	-	-	-	-	-	-	-
Cotton waste, dry, .	2	6.89	-	2.09	1.32	1.71	1.62	.89	1.26	.84	.83	.94	-	-	-	-	-	-	-

III. Refuse Substances — Concluded.	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOS- PHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Alumi- nic (oxides).	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
Cotton dust, . . . . .	1	34.46	50.83	-	-	.50	-	-	.19	-	-	.21	-	-	-	-	.90	.90	-	-	-	-	47.46
Glucose refuse, . . . . .	1	8.10	-	-	-	2.62	-	-	.15	-	-	.29	-	-	-	-	.18	.02	-	-	-	-	.07
Hop refuse, . . . . .	1	8.98	-	-	-	.98	-	-	.11	-	-	.20	-	-	-	-	.27	.10	-	-	-	-	.63
Sumac waste, . . . . .	1	63.06	6.80	-	-	1.19	-	-	3.25	-	-	-	-	-	-	-	1.14	3.25	-	-	-	-	2.25
El-el-grass, . . . . .	2	35.39	15.60	.96	.70	.83	1.61	.21	.91	.41	.22	.32	-	-	-	1.63	2.13	.11	-	-	-	-	1.06
Rockweed, green, . . . . .	1	68.50	23.70	-	-	.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockweed, dry, . . . . .	1	10.68	35.75	-	-	1.45	-	-	4.88	-	-	2.75	-	-	-	7.90	7.66	.21	-	-	-	-	10.40
Wet kelp, . . . . .	1	88.04	2.26	-	-	.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Blue-green alga ( <i>Lyngbia majuscula</i> ), dry, . . . . .	1	16.26	-	-	-	4.25	-	-	.79	-	-	.19	-	-	-	3.83	2.06	1.18	-	-	-	-	6.63
Mussel mud, wet, . . . . .	1	60.01	27.29	-	-	.21	-	-	8.17	-	-	.10	-	-	-	.70	.93	.14	3.48	-	-	-	-
Mussel mud, dry, . . . . .	1	2.24	72.02	-	-	.72	-	-	-	-	-	.35	-	-	-	-	23.39	-	8.26	-	-	-	37.60
Salt mud, . . . . .	2	53.37	41.19	.40	.39	.40	.33	.32	.93	-	-	-	-	-	-	.94	.91	.37	4.13	-	-	-	34.88
Fresh-water mud, . . . . .	1	40.37	-	-	-	1.37	-	-	.22	-	-	.28	-	-	-	-	1.27	.29	1.80	-	-	-	18.26
Muck, . . . . .	12	65.13	13.76	2.64	.26	1.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peat, . . . . .	9	61.60	7.71	1.40	.41	.76	-	-	-	-	-	-	-	-	-	-	.50	-	-	-	-	-	.38

[illegible]



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COMPILATION OF ANALYSES OF FODDER ARTI-  
CLES, FRUITS, SUGAR-PRODUCING PLANTS,  
DAIRY PRODUCTS, ETC.,

MADE AT

AMHERST, MASS.

— . . . —  
1868-1891.  
— — — —

PREPARED BY W. H. BEAL.

- A. ANALYSES OF FODDER ARTICLES.
  - B. ANALYSES OF FODDER ARTICLES WITH REFERENCE  
TO FERTILIZING INGREDIENTS.
  - C. ANALYSES OF FRUIT.
  - D. ANALYSES OF SUGAR-PRODUCING PLANTS.
  - E. DAIRY PRODUCTS.
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## A. Analyses of Fodder Articles.

N A M E.	Analyses.	ONE HUNDRED PARTS OF DRY MATTER CONTAIN —																Nutritive Ratio (Average).
		DRY MATTER.			PROTEIN.			FAT.			NITROGEN—FREE EXTRACT.			FIBRE.			Ash.	
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
<i>I. Green Fodders.</i>																		
Fodder corn, . . . . .	23	30.53	10.33	19.13	17.19	8.04	10.33	6.10	1.42	2.42	63.13	42.02	55.30	31.53	19.26	25.97	5.08	1:7.99
Fodder corn (ensilaged), . . . . .	26	28.69	13.12	22.03	12.58	5.98	8.11	6.49	1.82	3.94	65.69	42.99	55.79	38.92	17.67	26.68	5.38	1:10.80
Sorghum, . . . . .	6	23.18	12.38	17.41	11.34	7.46	8.74	2.00	1.21	1.55	64.93	47.65	56.15	29.27	22.00	26.73	6.83	1:11.62
Common millet, . . . . .	9	49.29	21.32	35.42	12.16	5.43	7.50	3.99	2.09	2.74	58.61	46.39	53.88	33.98	24.88	30.99	4.84	—
Japanese millet ("white head"), . . . . .	3	26.24	20.95	24.76	10.98	7.26	8.72	2.64	1.94	2.33	50.87	46.71	49.80	38.90	30.12	34.47	4.88	—
Japanese millet ("red head"), . . . . .	6	33.83	22.66	27.33	7.99	4.92	6.90	2.45	1.58	2.01	60.83	50.11	52.91	35.29	25.21	32.10	6.08	—
White kibi, . . . . .	2	24.26	22.85	23.56	15.14	10.79	12.87	1.61	1.50	1.56	53.66	52.30	52.91	31.70	23.03	27.37	5.19	—
Mochi millet, . . . . .	3	42.29	30.07	37.42	11.90	6.11	9.94	1.94	1.74	1.81	67.08	49.06	55.69	29.80	20.01	25.56	7.00	—
Mix, . . . . .	3	31.36	18.17	24.45	16.70	9.81	13.53	2.48	1.35	1.86	52.30	47.75	51.27	27.44	26.82	27.06	6.28	—
Green oats, . . . . .	5	28.82	16.51	20.03	20.47	7.06	13.85	3.32	2.02	2.68	50.69	40.81	45.90	33.12	25.20	29.70	7.87	1:9.97
Timothy ( <i>Phleum pratense</i> L.), . . . . .	2	35.00	34.26	34.63	8.83	8.20	8.52	2.07	1.95	2.01	51.33	51.23	51.27	33.23	32.50	32.87	5.33	1:10.96
Hungarian grass ( <i>Setaria Italica</i> Beauv.), . . . . .	1	—	—	25.93	—	—	9.38	—	—	1.01	—	—	57.80	—	—	24.66	7.15	1:6.86
Vetch and oats (1 part vetch and 9 parts oats), . . . . .	2	24.04	13.89	18.97	10.76	10.59	10.68	2.74	2.29	2.52	43.75	40.10	41.81	35.81	34.20	35.01	9.89	1:6.85
Horse bean, whole plant ( <i>Vicia faba</i> L.), . . . . .	1	—	—	15.17	—	—	16.68	—	—	2.31	—	—	47.09	—	—	28.17	5.75	1:2.71
Soja bean, whole plant ( <i>Soja hispida</i> Münch.), . . . . .	9	26.86	18.54	23.12	22.19	14.02	18.76	8.98	2.71	4.99	47.89	40.80	44.44	31.89	21.67	25.92	7.89	1:4.09
Cow-pea vines, . . . . .	3	21.19	18.16	19.63	17.93	11.24	14.56	2.90	1.81	2.46	60.62	46.13	52.42	25.88	21.87	23.59	6.92	1:5.82

## II. Hay and Dry Coarse Fodders.

Berracella ( <i>Ornithopus sativus</i> Brot.),	2	19.42	18.40	17.41	17.78	12.17	14.98	2.68	2.09	2.37	41.54	35.43	38.46	38.76	26.21	32.48	11.09	1:4.67
White lupine ( <i>Lupinus albus</i> L.),	1	-	-	14.85	-	-	18.71	-	-	2.41	-	-	42.87	-	-	31.18	5.03	-
Spanish moss ( <i>Tillandsia usneoides</i> L.),	1	-	-	39.20	-	-	4.45	-	-	2.54	-	-	57.73	-	-	32.81	2.67	-
<i>II. Hay and Dry Coarse Fodders.</i>																		
English hay (mixed hays),	6	91.94	86.96	88.73	11.93	8.75	9.94	2.77	2.09	2.54	54.43	47.11	49.12	35.55	29.21	31.98	6.44	1:11.33
Rowen of mixed hay,	4	91.16	80.29	88.10	14.70	11.63	13.45	5.03	2.60	3.91	53.52	41.92	45.48	31.50	25.11	28.88	8.28	1:6.36
Timothy hay,	4	92.76	89.46	91.43	9.02	7.24	8.32	2.65	1.95	2.20	54.43	50.01	51.73	36.59	29.21	32.90	4.86	1:11.44
Red-top hay ( <i>Agrostis vulgaris</i> With.),	4	93.19	91.76	92.30	8.40	6.41	7.88	1.69	1.50	1.60	54.74	50.32	52.63	34.11	31.12	32.92	4.97	1:12.06
Kentucky blue-grass ( <i>Poa pratensis</i> L.),	2	96.10	93.22	94.66	8.78	8.65	8.72	2.08	2.03	2.08	46.61	44.11	46.29	36.84	32.21	34.58	8.35	1:10.38
Orchard grass ( <i>Dactylis glomerata</i> L.),	4	91.62	90.86	91.17	11.29	7.57	8.98	3.56	2.40	2.91	47.34	43.50	45.15	35.79	34.12	34.88	7.05	1:10.47
Meadow fescue ( <i>Festuca pratensis</i> Huds.),	5	94.70	87.84	91.09	7.85	5.89	6.76	2.17	1.65	1.87	49.18	42.03	46.31	39.90	34.61	36.93	8.13	1:13.60
Perennial rye grass ( <i>Lolium perenne</i> L.),	4	93.64	90.50	92.60	16.56	6.59	11.71	3.15	1.59	2.37	55.77	38.82	48.14	30.86	26.79	29.84	8.14	1:7.40
Italian rye grass ( <i>Lolium italicum</i> A Br.),	4	92.62	90.70	91.54	9.75	6.20	8.15	2.07	1.39	1.95	52.80	43.09	49.14	36.90	31.27	33.94	7.52	1:10.90
Hungarian grass,	1	-	-	92.55	-	-	9.45	-	-	2.22	-	-	50.84	-	-	31.98	5.73	1:6.22
Barn-yard grass ( <i>Panicum crus-galli</i> L.),	1	-	-	93.35	-	-	15.27	-	-	1.95	-	-	30.24	-	-	33.72	10.02	1:2.94
Low meadow hay,	1	-	-	91.89	-	-	9.51	-	-	1.88	-	-	46.27	-	-	35.59	6.75	-
Millet,	5	93.85	91.90	93.00	8.11	7.09	7.59	2.67	.89	1.74	55.80	49.62	51.64	35.91	29.80	33.54	5.49	1:7.78
Oats in blossom,	1	-	-	93.57	-	-	6.58	-	-	2.92	-	-	50.03	-	-	34.08	6.41	1:14.23
Oats in milk,	1	-	-	90.45	-	-	10.86	-	-	2.69	-	-	46.02	-	-	34.32	6.08	1:7.90
Oats, ripe,	1	-	-	91.30	-	-	8.05	-	-	2.61	-	-	48.92	-	-	36.31	6.11	1:15.03
Winter rye in blossom,	1	-	-	91.45	-	-	10.66	-	-	2.57	-	-	47.40	-	-	32.97	6.40	1:8.28

## A. Analyses of Fodder Articles — Continued.

Analyses.	N A M E .	ONE HUNDRED PARTS OF DRY MATTER CONTAIN --																Nutritive Ratio (Average).			
		DRY MATTER.				PROTEIN.				FAT.				NITROGEN -- FREE EXTRACT.					Ash.		
		Max.		Min.		Aver.		Max.		Min.		Aver.		Max.		Min.				Aver.	
III. Hay and Coarse Dry Fodders -- Concluded.																					
1	Barley in milk,	-	-	89.75	-	-	10.26	-	-	2.76	-	-	52.91	-	-	29.12	4.95	1:9.50			
1	Japanese buckwheat,	-	-	94.29	-	-	10.80	-	-	2.22	-	-	38.60	-	-	36.02	12.36	-			
4	Dry fodder corn,	93.35	90.58	92.11	9.31	6.17	7.74	2.76	1.11	1.94	58.89	53.86	56.97	33.75	23.08	29.31	5.14	-			
25	Corn stover,	94.44	75.00	86.50	12.15	5.46	7.35	2.63	1.16	1.33	63.05	44.65	50.83	38.88	20.93	34.85	5.64	1:11.49			
1	Teosinte ( <i>Euchlana lazurlana</i> Dur. and Asch.),	-	-	93.94	-	-	9.71	-	-	1.28	-	-	53.18	-	-	28.88	6.95	-			
3	Mammoth red clover ( <i>Trifolium medium</i> L.),	92.68	82.47	88.58	18.50	14.06	15.75	2.25	1.86	2.13	48.98	46.51	44.77	33.72	20.16	27.51	9.84	1:5.10			
2	Medium red clover ( <i>Trifolium pratense</i> L.),	94.90	83.98	94.44	15.01	14.63	14.82	2.62	2.36	2.49	43.88	42.81	43.34	30.76	29.97	30.37	8.98	1:5.52			
6	Alaska clover ( <i>Trifolium hybridum</i> L.),	93.92	86.48	90.07	17.55	14.77	16.83	3.26	1.88	2.58	46.64	38.03	42.72	32.34	21.44	26.17	11.90	1:3.25			
5	Lucerne (alfalfa) ( <i>Medicago sativa</i> Desr.),	95.40	84.00	91.40	16.34	11.12	14.22	2.60	1.04	1.85	51.62	40.25	46.20	34.39	25.42	29.72	8.11	1:4.09			
1	Sand lucerne, in bloom ( <i>Medicago media</i> Pers.),	-	-	91.20	-	-	16.26	-	-	2.58	-	-	50.31	-	-	21.27	9.57	1:3.50			
2	Bohara clover ( <i>Medicago alba</i> Desr.),	93.64	91.50	92.57	14.93	11.81	13.37	4.79	1.85	3.32	51.36	38.83	45.08	33.05	28.08	30.57	7.66	-			
1	Blue melilot ( <i>Medicago cerulea</i> Desr.),	-	-	91.78	-	-	13.81	-	-	1.67	-	-	43.22	-	-	27.17	14.87	-			
1	Sainfoin ( <i>Onobrychis sativa</i> ),	-	-	87.83	-	-	17.70	-	-	4.49	-	-	42.27	-	-	26.95	8.54	-			
2	Sulla ( <i>Hedysarum coronarium</i> ),	91.68	89.59	90.81	17.03	16.90	16.97	3.16	2.39	2.78	58.66	41.89	50.26	28.96	12.38	20.87	9.32	-			
2	Hairy lotus ( <i>Lotus villosus</i> Thunb.),	89.32	87.64	88.48	16.12	13.49	14.81	3.00	2.69	2.85	57.82	50.80	54.29	24.48	15.07	19.78	8.27	-			
3	Soja bean,	93.88	79.91	86.10	19.06	15.10	16.68	8.33	5.62	6.77	51.28	41.09	46.96	25.64	20.76	22.78	6.90	1:4.33			

Cow-pes, . . . . .	3	90.70	90.25	90.43	17.17	16.96	17.05	4.49	3.81	4.08	51.41	46.06	47.93	23.58	19.06	21.87	9.29	1:4.82
Small pen ( <i>Lathyrus sativus</i> ), . . . . .	1	-	-	94.20	-	-	18.57	-	-	1.49	-	-	42.78	-	-	32.88	6.30	-
Serradella, . . . . .	3	92.80	87.23	90.44	17.97	15.26	17.03	2.91	2.37	2.55	50.23	44.49	46.18	25.92	24.37	25.15	7.09	1:4.85
Halvy vetch ( <i>Vicia villosa</i> Roth.), . . . . .	1	-	-	92.56	-	-	19.58	-	-	1.92	-	-	38.95	-	-	31.88	8.37	-
Common vetch ( <i>Vicia sativa</i> L.), . . . . .	2	91.65	90.55	91.10	15.76	14.42	15.09	2.60	2.30	2.50	44.34	43.29	43.80	30.68	30.05	30.37	8.24	1:3.87
Scotch tares, . . . . .	1	-	-	84.20	-	-	22.00	-	-	1.89	-	-	31.46	-	-	30.86	13.76	-
Vetch and oats, . . . . .	2	94.22	87.47	90.85	7.72	7.70	7.71	3.37	2.53	2.95	49.95	49.00	49.47	36.22	31.73	33.98	5.80	1:11.49
Horse-bean straw, . . . . .	1	-	-	90.85	-	-	9.89	-	-	1.51	-	-	37.77	-	-	41.44	9.59	1:8.55
Soja-bean straw, . . . . .	1	-	-	87.00	-	-	5.39	-	-	1.80	-	-	43.72	-	-	43.85	5.24	-
White daisy ( <i>Chrysanthemum Leucanthemum</i> L.), . . . . .	1	-	-	90.35	-	-	7.88	-	-	2.32	-	-	46.86	-	-	38.09	7.05	-
Dry carrot tops, . . . . .	1	-	-	90.24	-	-	20.12	-	-	2.01	-	-	50.39	-	-	13.61	13.87	-
Wheat straw, . . . . .	1	-	-	93.80	-	-	7.20	-	-	1.63	-	-	50.48	-	-	35.91	4.80	1:8.00
Barley straw, . . . . .	1	-	-	88.56	-	-	9.24	-	-	3.38	-	-	46.23	-	-	33.85	6.30	-
III. Roots, Bulbs, Tubers, etc.																		
Beets, red, . . . . .	7	14.51	9.75	12.17	15.40	7.82	12.29	1.76	.59	.94	79.33	66.87	72.19	7.56	4.29	6.00	8.58	1:8.24
Beets, sugar, . . . . .	11	19.53	9.87	14.73	17.44	7.32	10.97	.83	.58	.66	81.50	61.93	75.93	9.60	4.82	6.48	5.95	1:11.80
Beets, yellow fodder, . . . . .	1	-	-	9.40	-	-	12.78	-	-	1.80	-	-	67.50	-	-	7.83	10.09	1:8.33
Mangolds, . . . . .	3	13.08	11.73	12.25	12.84	7.83	10.37	1.01	.73	.88	73.38	70.32	71.75	9.54	7.08	7.94	9.06	1:9.94
Ruta-bagas, . . . . .	3	12.77	8.25	10.88	11.46	10.34	11.01	2.32	1.23	1.53	68.58	62.27	65.88	13.12	11.03	11.83	9.75	1:11.83
Turnips, . . . . .	3	12.80	8.22	9.78	10.81	9.67	10.12	2.05	1.42	1.74	70.62	65.91	69.44	12.61	10.12	11.23	8.47	1:13.26
Carrots, . . . . .	4	12.52	9.95	10.72	9.63	7.68	8.93	3.94	1.67	2.34	73.96	67.24	71.27	10.76	7.55	9.19	8.27	1:9.67

## A. Analyses of Fodder Articles—Concluded.

NAME.	Analyses.	ONE HUNDRED PARTS OF DRY MATTER CONTAIN —															Nutritive Ratio (Average).	
		DRY MATTER.			PROTEIN.			FAT.			NITROGEN—FREE EXTRACT.			FIBRE.				Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
III. Roots, Bulbs, Tubers, etc. — Concluded.																		
Paranips, . . . . .	1	-	-	19.66	-	-	6.68	-	-	3.37	-	-	74.65	-	-	7.67	7.43	-
Potatoes, . . . . .	10	21.95	13.91	18.78	13.56	6.24	10.01	.83	.17	.48	87.56	78.80	81.50	3.55	1.91	2.75	5.26	1:12.25
Apples, . . . . .	2	24.83	19.68	22.26	4.57	3.92	4.25	2.81	1.71	2.26	86.21	83.44	84.81	7.05	6.14	6.60	2.08	1:26.44
IV. Grains and Other Seeds.																		
Corn kernels, . . . . .	28	91.98	65.50	88.55	15.02	8.46	12.24	9.43	4.25	5.47	83.08	71.06	78.44	3.38	1.03	2.14	1.71	1:8.16
Corn kernels and cobs (corn and cob meal), . . . . .	36	94.00	83.91	88.71	15.06	7.82	10.00	5.27	3.36	4.08	81.41	70.13	76.73	10.41	5.63	7.56	1.62	-
Wheat grain, . . . . .	1	-	-	89.42	-	-	13.35	-	-	1.79	-	-	80.26	-	-	2.42	2.18	1:6.42
Broom-corn seed, . . . . .	1	-	-	85.90	-	-	11.21	-	-	4.05	-	-	74.05	-	-	8.34	2.85	-
Soja beans, . . . . .	3	94.15	80.73	85.83	35.98	32.58	33.87	21.89	18.42	20.19	34.88	32.87	33.98	7.57	5.15	6.02	5.84	1:2.61
Horse beans, . . . . .	1	-	-	86.72	-	-	30.03	-	-	1.11	-	-	56.48	-	-	8.11	4.27	1:2.24
V. Flour and Meal.																		
Corn meal, . . . . .	25	89.95	82.96	86.03	16.08	9.73	10.87	5.08	3.10	4.48	83.24	73.20	80.80	3.60	1.20	2.18	1.67	1:9.75
Hominy meal, . . . . .	3	91.89	89.30	90.75	11.88	11.20	11.81	12.22	4.89	9.33	78.07	68.00	72.55	4.78	3.69	4.08	2.43	1:8.82
Ground barley, . . . . .	2	87.81	86.36	87.10	11.17	10.42	10.60	2.19	1.60	1.94	78.26	77.46	77.79	7.37	6.86	7.11	2.86	1:9.72



## B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per Ton of 2,000 Pounds.
I. Green Fodders.												
Fodder corn, . . . . .	14	78.61	.407	4.84	.327	.048	.153	.091	.018	.148	.380	\$2 84
Fodder corn ensilage, . . . . .	1	71.60	.380	-	.330	.050	.100	.090	.020	.140	.040	1 68
Sorghum, . . . . .	7	82.19	.233	-	.229	.025	.076	.075	.012	.088	.136	1 09
White kibi, . . . . .	2	76.45	.469	1.22	.200	.045	.232	.148	.019	.138	.662	2 09
Mochi millet, . . . . .	3	62.68	.609	2.62	.407	.120	.201	.217	.021	.188	.708	2 65
Mix, . . . . .	3	75.69	.469	1.54	.363	.060	.249	.245	.021	.237	.527	2 38
Green oats, . . . . .	3	83.36	.469	1.31	.381	.217	.154	.134	.018	.130	.496	2 14
Vetch and oats, . . . . .	1	86.11	.236	1.72	.708	.031	.087	.030	.012	.094	.331	1 58
Horse bean, . . . . .	1	74.71	.675	1.45	1.370	.090	1.370	.620	.200	.330	2.040	3 87
Cow-pea vines, . . . . .	1	78.81	.274	1.47	.308	.063	.300	.099	.016	.088	.077	1 51
Serradella, . . . . .	2	82.59	.411	1.82	.420	.097	.480	.067	.021	.140	.097	1 92
White lupine, . . . . .	1	85.35	.440	.74	1.730	.680	3.070	.730	.170	.350	.900	3 39
Spanish moss, . . . . .	1	60.80	.279	1.04	.255	.263	.080	.122	.029	.030	.191	1 20
II. Hay and Dry Coarse Fodders.												
English hay, . . . . .	4	11.45	1.440	6.34	1.575	.180	.390	.240	.043	.391	.997	6 71
Rowen, . . . . .	2	12.48	1.748	9.57	1.966	.168	.814	.250	.064	.464	1.920	8 16

Red-top, . . . . .	4	7.71	1.150	4.69	1.020	.438	.571	.134	.036	.360	1.736	6 20
Kentucky blue-grass, . . . . .	2	5.84	1.320	—	1.894	.129	.398	—	.044	.431	2.863	6 45
Orchard grass, . . . . .	4	8.84	1.310	6.42	1.979	.225	.456	.297	.033	.414	2.060	6 55
Meadow fescue, . . . . .	6	8.89	.992	8.08	2.096	.301	.576	.187	.028	.399	1.537	5 63
Perennial rye grass, . . . . .	2	9.13	1.227	6.79	1.553	.307	.642	.337	.044	.559	2.262	6 16
Italian rye grass, . . . . .	4	8.71	1.189	—	1.273	.451	.857	.321	.071	.556	2.598	5 79
Salt hay, . . . . .	1	6.36	1.180	—	.718	.017	.371	.335	.028	.248	—	4 92
Japanese millet ("white head"), . . . . .	1	12.07	1.365	—	.788	—	.323	.328	.013	.418	1.228	6 81
Japanese buckwheat, . . . . .	1	5.72	1.929	—	3.320	.349	3.418	.421	.148	.852	.378	9 38
Fodder corn, . . . . .	7	7.85	1.783	4.91	.869	.175	.605	.500	.075	.542	1.270	7 40
Corn stover, . . . . .	16	9.12	1.043	3.74	1.400	.112	.622	.384	.068	.293	1.885	5 28
Teosinte, . . . . .	1	6.06	1.460	6.53	3.886	.109	1.597	.458	.021	.546	.315	8 72
Mammoth red clover, . . . . .	3	11.41	2.231	8.72	1.223	.389	3.141	.613	.111	.546	.779	9 38
Medium red clover, . . . . .	2	7.91	2.194	8.36	2.266	.210	1.689	.402	.099	.447	.919	9 91
Alsike clover, . . . . .	6	9.94	2.942	11.11	2.227	.309	2.153	.537	.197	.868	1.776	10 65
Lucerne (alfalfa), . . . . .	4	6.26	2.075	6.82	1.461	.814	2.211	.406	.078	.526	.513	8 92
Bokhara clover, . . . . .	2	7.43	1.975	7.70	1.632	.114	1.784	.847	.023	.558	.057	8 95
Blue melilot, . . . . .	1	8.22	1.919	13.65	2.786	.270	1.449	.260	.349	.544	4.008	9 55
Sainfoin, . . . . .	1	12.17	2.630	7.55	2.020	.540	1.160	.430	.040	.760	.470	11 57
Sulla, . . . . .	2	9.39	2.460	—	2.063	.223	2.497	.350	.114	.453	.614	10 68
Lotus villosus, . . . . .	2	11.52	2.095	8.23	1.807	.499	2.220	.476	.112	.594	.976	9 37



## B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients — Continued.

NAME.												
II. Hay and Dry Coarse Fodders—Concluded.												
Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per Ton of 2,000 Pounds.	
2	6.30	2.320	6.47	1.079	.148	2.760	1.178	.115	.667	.977	\$9.54	
1	9.00	1.635	8.40	.913	.122	2.006	.683	.046	.527	.832	6.96	
1	5.80	2.487	-	1.990	.469	1.373	.276	.138	.592	1.081	10.80	
2	7.39	2.697	10.00	.852	.656	2.545	.461	.066	.777	.699	10.64	
1	15.80	2.984	-	3.004	.238	1.698	.354	.400	.815	4.002	13.61	
3	9.91	1.299	9.58	1.349	.420	.653	.265	.098	.580	.521	6.24	
1	13.00	.750	-	1.322	-	.436	.460	.035	.397	.218	4.15	
1	9.65	.279	6.37	1.253	.164	1.302	.191	.032	.435	1.110	2.54	
1	9.76	3.130	12.52	4.803	4.028	2.089	.667	.118	.612	.098	15.52	
1	11.44	1.310	5.36	2.088	.183	.572	.180	-	.303	2.380	6.58	

Turnips, . . . . .	2	89.49	.178	1.01	.395	.078	.089	.027	.009	.104	.055	1 06
Carrots, . . . . .	2	89.79	.147	9.22	.506	.062	.067	.023	.009	.093	.019	1 04
Parsnips, . . . . .	1	80.34	.217	-	.617	.006	.088	.045	.005	.187	.019	1 48
Potatoes, . . . . .	1	79.75	.207	.99	.294	.013	.007	.020	.002	.086	.006	1 03
Apples, . . . . .	2	79.91	.130	.41	.190	.030	.030	.030	.003	.010	.003	49
<i>IV. Grains and Other Seeds.</i>												
Corn kernels, . . . . .	13	10.88	1.822	1.53	.404	.034	.032	.206	.019	.699	.020	6 37
Corn kernels and cobs (corn and cob meal), . . . . .	29	8.96	1.409	-	.472	.059	.018	.176	.011	.571	.430	5 88
Soja beans, . . . . .	2	18.33	5.303	4.99	1.991	.275	.419	.909	.216	1.868	.093	21 96
<i>V. Flour and Meal.</i>												
Corn meal, . . . . .	2	13.52	2.050	1.42	.435	.064	.034	.187	.015	.707	.005	7 85
Hominy feed, . . . . .	1	8.93	1.630	2.21	.490	-	.180	.280	-	.980	-	6 14
Ground barley, . . . . .	1	13.43	1.550	2.06	.341	.169	.091	.173	.013	.680	.699	6 25
Wheat flour, . . . . .	1	9.83	2.210	1.22	.540	-	.170	.050	-	.570	-	8 65
Pea meal, . . . . .	1	8.85	3.080	2.68	.993	.618	.302	.302	.027	.620	.122	11 31
<i>VI. By-products and Refuse.</i>												
Linseed cake, old process, . . . . .	4	8.02	5.390	6.57	1.214	.860	.664	.763	.060	1.780	.340	21 49
Linseed cake, new process, . . . . .	4	7.35	5.808	5.04	1.286	.823	.663	.655	.062	1.628	.345	22 80
Cotton-seed meal, . . . . .	9	8.96	6.447	6.49	1.723	.291	.587	.589	.020	2.333	.457	26 25

## B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients — Concluded.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per Ton of 2,000 Pounds.
Yl. By-products and Refuse — Concluded.												
Wheat bran, . . . . .	5	11.39	2.679	6.44	1.625	.159	.108	.899	.019	2.845	.141	\$14.58
Wheat middlings, . . . . .	1	9.18	2.630	2.30	.630	.110	.200	.210	-	.950	-	10.63
Rye middlings, . . . . .	1	12.54	1.840	3.52	.810	.080	.090	.820	.020	1.290	.170	8.46
Gluten meal, . . . . .	4	8.53	5.430	.65	.045	.018	.050	.035	.069	.425	-	19.01
Spent brewer's grain, . . . . .	1	6.98	3.050	6.15	1.550	.347	.296	.286	.159	1.290	1.770	12.14
Cocoa dust, . . . . .	1	7.10	2.299	6.35	.630	-	.630	-	-	1.340	-	11.22
Broom-corn waste (stalks), . . . . .	1	10.37	.870	4.70	1.868	-	.242	.170	-	.460	1.000	5.09
Cotton hulls, . . . . .	3	10.63	.750	2.61	1.080	-	.200	.260	-	.180	.060	3.74
Apple pomace, . . . . .	2	80.50	.927	.271	.194	.026	.037	.028	.008	.018	.009	90
Corn cobs, . . . . .	8	12.09	.504	.815	.598	.071	.025	.045	.009	.083	.190	2.44
Palmetto root, <sup>1</sup> . . . . .	1	11.51	.540	.393	1.380	.345	.045	.004	.017	.157	.410	8.20

*C. Analyses of Fruits.*

NAME.	Date.	Dry Matter.	Specific Gravity of Juice.	Temperature C. of Juice (Degrees).	Total Sugar in Juice.	Glucose in Juice.	Cane Sugar in Juice.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.	Per ct.			Per ct.	Per ct.	Per ct.	C. C.
Apple (Baldwin), . . .	Sept. 1,	20.14	1.055	12—15	3.09	-	-	-
Apple (Baldwin), . . .	Oct. 9,	19.66	1.065	12—15	6.25	-	-	-
Apple (Baldwin), . . .	Nov. 27,	-	1.075	12—15	10.42	-	-	-
Code Island Greening, . .	Sept. 1,	20.27	1.055	12—15	3.16	-	-	-
Code Island Greening, . .	Oct. 9,	19.68	1.066	12—15	7.14	-	-	-
Code Island Greening,† . .	Nov. 27,	20.25	1.080	12—15	11.36	-	-	-
Ar (Bartlett), . . .	Aug. 31,	15.00	1.060	12—15	4.77	-	-	-
Ar (Bartlett), . . .	Sept. 7,	16.55	1.060	12—15	5.68	-	-	-
Ar (Bartlett), . . .	Sept. 20,	-	1.065	12—15	8.62	-	-	-
Ar (Bartlett),‡ . . .	Sept. 22,	-	1.060	12—15	8.93	-	-	-
Unberries, . . .	-	10.71	1.025	15	1.35	-	-	-§
Unberries, . . .	1878.	10.11	1.025	15	1.70	-	-	-
Early York Peach (ripe), .	-	-	1.045	25	-	1.92	6.09	45
Early York Peach (nearly ripe),	-	10.96¶	1.039	25	-	1.36	4.12	42.3
Lawford Peach (nearly ripe),	-	-	1.050	18	-	2.19	7.02	85.6
Lawford Peach (mellow), .	-	11.36¶	1.055	18	-	1.70	8.94	76
Lawford Peach (not mellow),	-	11.88¶	1.045	22	-	1.67	5.92	64

One part Na<sub>2</sub>CO<sub>3</sub> in 100 parts of water.

Picked October 9.

Picked September 7.

§ Free acid, 2.25 per cent.

|| Free acid, 2.43 per cent.

¶ In pulp, kept ten days before testing.

C. *Analyses of Fruits*—Continued.

[Wild and cultivated grapes.]

NAME.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter.	
	<b>1876.</b>			Per ct.	Per
Concord, . . . . .	July 17,	1.0175	31	8.30	
Concord, . . . . .	July 20,	1.0150	31	8.10	
Concord, . . . . .	Aug. 2,	1.0200	25	9.94	
Concord, . . . . .	Aug. 16,	1.0250	28	10.88	2
Concord, . . . . .	Aug. 30,	1.0500	25	15.58	8
Concord, . . . . .	Sept. 13,	1.0670	23	17.48	13
Concord, . . . . .	Sept. 4,	1.0700	18	19.82	16
Purple Wild Grape, . . . .	July 19,	1.020	31	9.00	
Purple Wild Grape, . . . .	Aug. 4,	1.020	28	12.25	1
Purple Wild Grape, . . . .	Aug. 16,	1.025	28	12.48	2
Purple Wild Grape, . . . .	Aug. 30,	1.050	26	16.58	6
White Wild Grape, . . . .	Aug. 31,	1.050	26	16.48	9
Hartford Prolific, . . . .	Sept. 5,	1.060	22	17.39	13
Ives' Seedling, . . . . .	Sept. 6,	1.070	26	20.15	15
Iona, . . . . .	Sept. 7,	1.080	21	24.56	15
Iona (mildewed), . . . .	Sept. 7,	1.045	26	15.41	6
Agawam, . . . . .	Sept. 11,	1.075	20	20.79	17
Wilder, . . . . .	Sept. 11,	1.064	20	16.53	13
Delaware, . . . . .	Sept. 12,	1.080	24	23.47	17
Charter Oak, . . . . .	Sept. 12,	1.080	24	15.98	8
Israelia, . . . . .	Sept. 16,	1.075	23	19.67	9
Bent's Seedling, . . . . .	Sept. 20,	1.080	21	20.65	16
Adirondack, . . . . .	Sept. 20,	1.065	21	15.11	13
Catawba, . . . . .	Oct. 16,	1.080	13	23.45	17
	<b>1877.</b>				
Wilder, . . . . .	Sept. 11,	1.065	23	16.41	13
Charter Oak, . . . . .	Sept. 12,	1.055	23	16.22	9
Concord, . . . . .	Sept. 13,	1.065	24	15.90	13
Concord, . . . . .	Sept. 26,	1.075	24	19.34	15
Eumalan, . . . . .	Sept. 24,	1.065	16	19.62	13
Wild White Grape, . . . .	Sept. 5,	1.050	22	15.57	7
Wild White Grape (shrivelled), .	Sept. 20,	1.060	16	20.02	10
Wild Purple Grape (shrivelled), .	Sept. 20,	1.045	16	16.69	8

\* One part of pure Na<sub>2</sub>CO<sub>3</sub> in 100 parts water.

C. *Analyses of Fruits*—Continued.

[Effect of girdling on grapes.]

NAME AND CONDITION.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter at 100° C.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. requir- ed to neutralize 100 parts juice.
	<b>1877.</b>			Per ct.	Per ct.	Per ct.	C. C.
atford Prolific, not girdled, . . .	Sept. 3,	1.045	19	12.85	8.77	68.25	111.4
atford Prolific, girdled, . . .	Sept. 3,	1.065	19	17.18	12.50	72.76	100
der, not girdled, . . .	Sept. 3,	1.055	19	15.41	10.42	67.62	108.2
der, girdled, . . .	Sept. 3,	1.075	19	17.24	14.70	85.26	88.4
aware, not girdled, . . .	Sept. 4,	1.065	19	15.75	11.76	74.66	101.2
aware, girdled, . . .	Sept. 4,	1.075	19	19.14	15.15	79.16	94.4
swam, not girdled, . . .	Sept. 4,	1.080	19	16.60	11.37	68.48	128.2
swam, girdled, . . .	Sept. 4,	1.075	19	18.45	16.31	87.42	114.8
, not girdled, . . .	Sept. 6,	1.0625	22	16.60	13.51	68.31	131.4
, girdled, . . .	Sept. 6,	1.085	22	21.48	15.63	72.76	125.6
cord, not girdled, . . .	Sept. 6,	1.045	22	13.46	7.46	55.42	182.4
cord, girdled, . . .	Sept. 6,	1.070	22	17.53	13.88	79.18	102.8
cord, not girdled, . . .	Sept. 26,	1.065	22	17.63	13.70	78.27	86
cord, girdled, . . .	Sept. 26,	1.080	22	24.47	19.61	80.13	76.8
cord, not girdled, . . .	Oct. 5,	1.075	12	20.92	17.50	85.37	42
cord, girdled, . . .	Oct. 5,	1.085	12	-	17.86	-	54
		100 PARTS OF GRAPES CONTAINED —					
	Date.						
		Ash.	Moisture.	Glucose.	Tartaric Acid.		
	<b>1889.</b>						
cord, not girdled, . . .	Sept. 23,	-	84.69	6.24	.75		
cord, girdled, . . .	Sept. 23,	.42	83.00	8.13	.85		
cord, not girdled, . . .	Oct. 8,	.53	84.51	6.09	.48		
cord, girdled, . . .	Oct. 8,	.37	82.69	8.50	.50		
	<b>1890.</b>						
cord, not girdled, . . .	Sept. 25,	.47	86.49	7.36	1.15		
cord, girdled, . . .	Sept. 25,	.48	84.93	9.29	1.17		
cord, not girdled, . . .	Oct. 9,	.53	85.39	7.67	.71		
cord, not girdled, . . .	Oct. 9,	.59	85.11	6.65	.51		
cord, girdled, . . .	Oct. 9,	.54	85.15	9.12	.74		

\* One part of pure  $\text{Na}_2\text{CO}_3$  in 100 parts water.

*C. Analyses of Fruits—Continued.*

[Effect of fertilization upon the organic constituents of wild

NAME.	Date.	Dry Matter.	Specific Gravity.	Temperature C. (Degrees).	Per Cent. of Glucose.	Per Cent.
	<b>1877.</b>					
Wild Purple Grape Berries, .	Sept. 20,	16.31	-	-	8.03	
Wild Purple Grape Berries, .	"	19.55	-	-	13.51	
Wild Purple Grape Juice, . .	"	-	1.045	16	8.22	9
Wild Purple Grape Juice, . .	"	-	1.065	16	13.51	1
Wild White Grape Berries, . .	"	20.02	-	-	-	
Wild White Grape Berries, . .	"	21.65	-	-	-	
Wild White Grape Juice, . . .	"	-	1.060	16	10.00	1
Wild White Grape Juice, . . .	"	-	-	-	14.29	

[Effect of fertilization upon the ash constituents of grape

NAME.	Date.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferrie Oxide.	Phosphoric Acid.	Insoluble.
	<b>1876.</b>							
Wild Purple Grapes, .	Sept. 13,	50.33	.15	22.23	5.59	.79	17.40	
Wild Purple Grapes, .	Sept. 20,	62.65	.85	14.24	3.92	.53	13.18	
Concord Grapes, . .	July 7,	41.73	5.04	25.03	7.80	.55	18.48	
Concord Grapes, . .	July 17,	47.34	1.13	24.21	-	.75	21.38	
Concord Grapes, . .	Aug. 18,	51.14	3.19	16.20	6.38	.65	20.77	
Concord Grapes, . .	Sept. 13,	57.15	4.17	11.30	3.10	.40	12.47	1
	<b>1878.</b>							
Concord Grapes, . .	Oct. 3,	64.65	1.42	9.13	3.63	.50	14.87	

*C. Analyses of Fruits—Concluded.*

[Ash analyses of fruits and garden crops.]

NAME.	Ash.	100 PARTS OF ASH CONTAINED—						
		Potash.	Soda.	Lime.	Magnesia.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.
Concord Grape (fruit), . . .	-	51.14	3.19	16.20	6.38	.65	20.77	1.67
Unfermented juice, . . .	-	50.85	.48	3.69	4.25	.10	6.43	.90
Fermented juice, . . .	-	40.69	-	6.35	6.24	-	9.04	-
Skins and pulp, . . .	-	7.70	.42	57.36	8.80	.08	24.40	1.32
Seeds, . . . . .	3.08	6.71	-	-	3.03	-	17.20	.29
Stems of grapes, . . .	4.60	20.91	-	20.20	8.45	-	17.75	2.09
Young branches,* . . .	-	24.71	.94	40.63	10.66	1.08	17.16	4.92
Wood of vine,† . . .	2.97	22.57	-	9.72	4.28	-	14.07	23.84
Clinton Grape (fruit), . . .	-	58.45	3.51	13.34	7.37	.90	18.19	-
Goldwin Apple, . . .	-	63.54	1.71	7.28	5.52	1.08	20.87	3.68
Rawberry (fruit),‡ . . .	.52	49.24	3.23	13.47	8.12	1.74	18.50	5.66
Rawberry (fruit),§ . . .	-	58.47	-	14.64	6.12	3.37	17.40	-
Rawberry vines, . . .	3.34	10.62	13.35	36.63	3.83	6.91	14.48	14.17
Ranberry (fruit), . . .	.18	47.96	6.58	18.58	6.78	-	14.27	-
Ranberry vines, . . .	2.45	12.98	3.27	16.49	10.33	3.35	10.94	34.04
Currants, red, . . .	.47	47.68	4.02	18.96	6.23	1.20	21.91	-
Currants, white, . . .	.59	52.79	3.00	17.08	5.68	2.67	18.78	-
Crawford Peach, sound, . . .	-	74.46	-	2.64	6.29	.58	16.02	-
Crawford Peach, diseased,   . . .	-	71.30	-	4.68	5.49	.46	18.07	-
Branch, sound, . . .	-	26.01	-	54.52	7.58	.52	11.37	-
Branch, diseased,   . . .	-	15.67	-	64.23	10.28	1.45	8.37	-
Asparagus stems, . . .	-	42.94	3.58	27.18	12.77	1.22	12.31	.08
Asparagus roots, . . .	-	56.43	5.42	15.48	7.57	-	15.09	3.67
Onions, . . . . .	-	38.51	1.90	8.20	3.65	.58	15.80	3.33

\* With tendrils and blossoms. † One year old. ‡ Wilder. § Downing. || Yellows.



*D. Analyses of Sugar-producing Plants*

[Composition of sugar beets raised upon the college grounds during  
1870 and 1871.]

NAME.	Date.	Brix Saccharom- eter (Degrees).	Per of 8
Electoral, . . . . .	Sept. 10,	14	15
Imperial, . . . . .	" 12,	15	15
Vilmorin, . . . . .	" 13,	14.5	15
Imperial, . . . . .	" 18,	14	16
Imperial, . . . . .	Oct. 11,	15	15
Electoral, . . . . .	" 16,	15	15
Vilmorin, . . . . .	" 18,	16	15
Imperial, . . . . .	Nov. 14,	15	15
Vilmorin, . . . . .	" 21,	15.5	15
Vienna Globe,* . . . . .	Sept. 19,	11	8
Common Mangold,* . . . . .	" 19,	9	5

\* Fodder beets.

[Percentage of sugar in different varieties of sugar beets grown on  
during the season of 1882.]

NAME.	Source of Seed.	Weight Pounds
I. Vilmorin, . . . . .	Saxony, .	$\frac{1}{2}$ to
II. Vilmorin, . . . . .	Saxony, .	$\frac{1}{2}$ to
I. White Imperial, . . . . .	Saxony, .	$\frac{1}{2}$ to
II. White Imperial, . . . . .	Saxony, .	$1\frac{1}{2}$ to
New Imperial, . . . . .	Saxony, .	$1\frac{1}{2}$ to
I. White Magdeburg, . . . . .	Saxony, .	$1\frac{1}{2}$ to
II. White Magdeburg, . . . . .	Silesia, .	$1\frac{1}{2}$ to
Quedlinburg, . . . . .	Saxony, .	$1\frac{1}{2}$ to
White Silesian, . . . . .	Silesia, .	$1\frac{1}{2}$ to

*D. Analyses of Sugar-producing Plants — Continued.*

[Effect of soil and fertilization on Electoral sugar beets.\*]

SOIL.	MANURE.	Specific Gravity Brix (Degrees).	Per Cent. of Sugar in Juice.	Non-saccharine Substances.	Cane Sugar in Soluble Matter.
dy loam, .	Fresh yard-manure, .	16.5	12.50	4.00	75.08
fish loam, .	Fresh yard-manure, .	15.5	11.05	4.45	71.30
rm alluvial, .	Yard-manure and chemicals, . . .	12.75	9.17	3.58	71.92
rm alluvial, .	Fresh hog-manure, .	13.5	9.53	3.97	70.06
ht, sandy soil,	No manure, . . .	18.5	13.73	4.77	74.21
rvial soil, .	Brighton fish, . .	14.5	11.15	3.35	76.90
vy soil, .	Yard-manure, . . .	12.25	8.15	4.10	66.53
-	-	13.5	9.90	3.60	73.33

\* Not raised on college farm (Connecticut valley).

[Effect of fertilization on sugar beets.\*]

FERTILIZERS.	PERCENTAGES OF SUGAR IN JUICE.		
	Freeport.	Electoral.	Vilmorin.
h horse-manure, . . . .	11.96	9.42	7.80
d guano without potash, . .	10.99	10.10	10.20
d guano with potash, . . .	12.55	13.24	10.50
ite and superphosphate, . .	13.15	12.16	10.50
hate of potash, . . . .	14.52	14.32	12.78
nd year after stable-manure, .	13.49	12.78	12.19

\* All were grown on the same soil, — sandy loam (college)

*D. Analyses of Sugar-producing Plants — Continued.*

[Effect of different modes of cultivation on Electoral sugar beets.]

LOCALITY OF BEET-FIELD.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Cane Sugar.	Non-saccharine Substances.
1. Sing Sing, N. Y., . . . .	1872-73	11	7.80	3.20
2. Washington, N. Y., . . . .	"	14	10.97	3.03
3. South Hartford, N. Y., . . . .	"	15	11.70	3.30
4. Greenwich, N. Y., . . . .	"	12	9.50	2.50
5. Frankfort, N. Y., . . . .	"	13.5	11.00	2.50
6. Albion, N. Y.,* . . . .	"	18	15.10	2.90
Albion, N. Y.,† . . . .	"	14	9.70	4.30

\* From beets weighing from 1½ to 2 pounds. † From beets weighing from 10 to 14 pounds.

1. Soil, loam resting on clayish hard-pan, had been for several years in grass. Tomatoes had been the preceding crop. Five hundred pounds of a phosphatic blood guano were applied before planting.

2. Soil, a clayish loam, had been ploughed seven inches deep. A liberal amount of rotten sheep-manure was placed in trenches and covered by running two furrows together, thus forming a ridge on which the seed were planted.

3. Soil, a gravelly loam, which had been richly manured with stable compost and twice ploughed before planting.

4. Soil, a sandy loam, underlaid by fine sand. The seed were planted on ridges, which covered trenches containing a little rotten stable-manure.

5. No details of modes of cultivation received.

6. Soil, a dark, reddish-brown, rich, deep, sandy loam. Clover had been raised for two years previous to a crop of carrots, which preceded the sugar beets. The beets were the second crop after the application of twenty loads of stable-manure per acre.

*Composition of Canada-grown Sugar Beets.*

[1872 and 1873.]

WHERE GROWN.	Weight of Roots.	Specific Gravity of Juice (Brix).	Temperature of Juice.	Per Cent. of Cane Sugar in Juice.
Echaillon de Montreal, . . . .	2 to 2½ lbs.	15.4°	64° F.	11.38
Riviere du Loup, . . . .	2 to 3½ lbs.	14.5°	63° F.	10.20
Chambly, . . . .	2 to 2½ lbs.	13.2°	63° F.	9.02
Maskinonge, . . . .	2 to 3 lbs.	13.4°	63° F.	8.83

## D. Analyses of Sugar-producing Plants — Continued.

[Early Amber Cane.]

DATE.	CONDITION OF CANE.	Brix Saccharometer (Degrees).	Temperature C. (Degrees).	Glucose.	Cane Sugar.	Soda Solution required to neutralize 100 parts of Juice.	Solids.
<b>1879.</b>				Per ct.	Per ct.	C. C.	Per ct.
Aug. 15, .	No flower stalks in sight,*	4.2	27	2.48	None	6.8	7.93
Aug. 16, .	No flower stalks in sight,*	5.8	24	4.06	None	9.0	11.10
Aug. 20, .	Flower stalks developed,*	7.9	24	3.47	2.16	7.0	13.00
Aug. 24, .	Flowers open,*	8.7	23	3.70	3.00	4.0	14.07
Aug. 27, .	Plants in full bloom,*	10.0	25	3.65	4.13	10.0	15.48
Aug. 30, .	Seed forming,*	9.5	30	4.00	3.81	9.5	16.14
Sept. 2, .	Seed in milk,*	10.7	27	3.86	4.41	9.5	15.85
Sept. 9, .	Seeds still soft,*	12.1	22	3.21	6.86	9.5	26.13
Sept. 9, .	Stripped on Sept. 2,*	12.8	22	3.77	6.81	9.5	26.76
Sept. 18, .	Left on field without stripping,*	13.2	22	3.57	7.65	-	-
Sept. 18, .	Tops removed,*	13.8	22	3.16	8.49	-	-
Sept. 18, .	Tops and leaves removed on Sept. 9,*	11.5	22	3.16	5.85	-	-
Sept. 18, .	Tops removed; left on field 9 days,*	12.8	22	10.00	.60	-	-
Sept. 21, .	Juice from the above,*	13.0	21	-	-	-	-
Sept. 23, .	Juice from the above,*	15.0	18	-	-	-	-
Sept. 25, .	Left on field 3 weeks,†	19.8	21	11.91	6.27	-	-
Sept. 28, .	Left on field 3 weeks,†	17.8	12	16.60	-	-	-
Oct. 4, .	Left on field 3 weeks,†	16.1	17	8.62	6.16	12.0	-
Oct. 7, .	Freshly cut. Ground with leaves,†	16.7	20	4.16	9.94	6.8	-
Oct. 8, .	Freshly cut. Stripped two weeks,†	12.8	17	5.16	5.27	7.0	-
Oct. 9, .	Freshly cut. Stripped two weeks,†	18.4	17	7.57	-	10.6	-
Oct. 14, .	Several weeks old,†	18.2	15	10.42	-	10.4	-
Oct. 18, .	Several weeks old,†	15.1	23	7.57	-	-	-
Oct. 19, .	Several weeks old,†	15.5	15	9.22	-	13.6	-
Oct. 22, .	Several weeks old,†	16.2	16	8.30	-	-	-
Oct. 23, .	Several weeks old,†	18.3	17	11.30	5.5	14.0	-
Oct. 24, .	Several weeks old,†	16.6	15	8.63	-	9.0	-
		100 PARTS OF CANE CONTAINED —					
		Moisture.	Glucose.	Cane Sugar.	Total Sugar.		
<b>1890.</b>							
October, .	Early Tennessee sorghum, mature, .	77.43	1.79	3.21	5.00	Grown on station grounds.	
October, .	Price's new hybrid, ripe, .	77.80	2.92	3.78	6.70		
October, .	Kansas orange, green, .	80.67	2.38	3.63	6.01		
October, .	New orange, green, .	78.30	2.96	3.85	6.81		
October, .	Honduras, green, .	77.55	3.08	4.01	7.09		

\* Raised on the college farm.

† Raised by farmers in the vicinity of the college.

*D. Analyses of Sugar-producing Plants—Concluded.*

[Composition of the juice of corn stalks and melons.]

VARIETY.	Specific Gravity.	Temperature C. (Degrees).	Glucose.	Cane Sugar in Juice.	Solids.
Northern corn,* . . . .	1.023	27	Per ct. 4.35	Per ct. 0.28	Per ct. 15.18
Black Mexican sweet corn,† . .	1.048	27	2.06	7.02	17.44
Evergreen sweet corn,‡ . . . .	1.052	—	4.85	5.70	20.38
Common sweet corn,§ . . . .	1.035	—	6.60	None.	—
Common yellow musk-melon,§ . .	1.040	26	1.67	2.65	—
White-flesh water-melon, . . . .	1.025	18	2.91	2.16	—
Red-flesh water-melon, . . . .	1.025	22	3.57	2.18	—
Red-flesh water-melon, . . . .	1.025	19	3.84	1.77	—
Nutmeg musk-melon,   . . . .	1.030	19	3.33	2.11	—
Nutmeg musk-melon,¶ . . . .	1.050	20	2.27	5.38	—
Nutmeg musk-melon,** . . . .	1.030	19	2.50	1.43	—

\* Tassels appearing.

† Ears ready for the table.

‡ Kernels somewhat hard.

§ Fully ripe.

|| Not ripe.

¶ Ripe.

\*\* Over-ripe.

*E. Analyses of Dairy Products.*

	Analyses.	Solids.			Fat.			Curd.			Salt.			Ash.
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	
Whole milk, . . . . .	50	16.70	11.96	13.80	6.46	2.48	3.85	-	-	3.20	-	-	-	.70
Skim-milk, . . . . .	-	-	-	10.19	-	-	.37	-	-	3.53	-	-	-	.80
Buttermilk, . . . . .	-	-	-	8.16	-	-	.21	-	-	2.79	-	-	-	.80
Cream, . . . . .	59	23.51	21.30	25.26	20.90	13.74	17.47	-	-	-	-	-	-	.62
Butter, . . . . .	24	92.89	87.05	89.17	89.05	81.43	83.98	.89	.51	.66	6.45	3.61	4.80	-
Whole-milk cheese (Jersey),*	1	-	-	62.94	-	-	37.92	-	-	22.13	-	-	-	3.39
Whole-milk cheese,* . . . . .	1	-	-	64.17	-	-	34.94	-	-	26.69	-	-	-	3.14
Cheese from milk skimmed after twelve hours' standing,* . . . . .	1	-	-	62.70	-	-	27.81	-	-	30.37	-	-	-	4.52
Cheese from milk skimmed after twenty-four hours' standing,* . . . . .	1	-	-	57.78	-	-	23.42	-	-	31.89	-	-	-	2.35
Cheese from milk skimmed after thirty-six hours' standing,* . . . . .	1	-	-	56.05	-	-	17.67	-	-	33.24	-	-	-	5.14
Cheese from milk skimmed after forty-eight hours' standing,* . . . . .	1	-	-	54.59	-	-	15.77	-	-	34.94	-	-	-	3.88
Cheese from skim-milk, with addition of buttermilk,* . . . . .	1	-	-	51.62	-	-	18.35	-	-	28.63	-	-	-	4.64
Genuine oleomargarine cheese,* . . . . .	1	-	-	62.10	-	-	31.66	-	-	25.94	-	-	-	4.50

\* From analyses made in 1875.

*E. Salt for Meat Packing and Dairy Purposes.*

KIND AND SOURCE.	Molality 100° C.	Sodium Chloride	Calcium Sulphate.	Calcium Chloride.	Magnesium Chloride.	Sodium Sulphate.	Magnesium Sulphate.	Insoluble Matter.	Remarks.
Rock salt of Petite Anse, La.,	.330	98.882	.782	.004	.003	.070	.070	—	Sent on for examination. Sulphuric acid: trace.
Rock salt of Neyba, San Domingo, W. I.,	.300	98.330	1.480	—	.090	—	—	—	
Solar salt, Onondaga, N. Y.,	2.500	96.004	1.316	.082	.089	—	—	—	
Solar salt, Hocking Valley, O.,	2.130	97.512	None.	.234	.089	—	—	—	
Solar salt, Saginaw Valley, Mich.,	3.344	96.813	.316	.356	.140	—	—	—	
Solar salt from Kansas,	4.950	93.060	1.220	—	.240	.350	.180	—	
Solar salt, Lincoln County, Neb.,	1.200	98.130	.280	—	.080	.390	None.	—	
Common fine and boiled salt, Onondaga, N. Y.,	3.000	96.363	1.356	.155	.186	—	—	—	
Common fine and boiled salt, Portsmouth, Mich.,	6.762	90.682	.806	.974	.781	—	—	—	
Common fine and boiled salt, Mason City, O.,	3.470	96.789	—	.614	.041	—	—	—	
Dairy and table salt, Ashton's (English),	0.760	97.632	1.430	—	.060	—	.048	.050	Sulphuric acid: trace.
Onondaga dairy salt,	0.700	97.832	1.283	—	.037	.026	.023	.120	
Fine salt, Bulletin 26, I.,	3.280	95.091	1.487	.082	.075	—	—	.045	
Fine salt, Bulletin 26, II.,	4.591	94.012	1.177	.143	.049	—	—	.023	
Fine salt, Bulletin 26, III.,	4.616	94.236	.999	.071	.026	—	—	.082	
Dairy salt, sent on from Amherst, Mass.,	0.145	98.520	1.009	.189	.065	—	—	.072	
Ashton salt (sent on),	.760	97.650	1.430	—	.060	—	.060	.050	
Onondaga factory-filled (sent on),	.600	96.280	.910	—	—	.080	.060	.120	
Dairy salt, sent on from Amherst,	.505	96.262	.877	.168	.046	—	—	.202	
Rock salt from Retsof salt mines,	2.600	95.940	.420	.330	.010	—	—	.700	
Royal salt,	.840	97.877	1.108	.016	.010	—	—	.102	Sulphuric acid: trace.
Excelsior salt,	.320	98.009	1.644	.013	.014	—	—	.020	
Genesee salt,	.285	98.513	1.160	.010	.012	—	—	.010	
Genesee salt,	.235	98.563	1.137	.045	.020	—	—	—	
Bradley salt,	.200	98.576	1.186	.029	.007	—	—	—	
Hight's Eureka salt,	.403	96.801	.908	.263	.065	—	—	—	
Worcester refined salt,	.565	97.536	1.376	.067	.027	—	—	—	

## METEOROLOGY.

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1890.

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The meteorological observations have been continued as in previous years. The temperature, the force and direction of the wind, and the amount of cloudiness, are recorded each day at 7 A.M., 2 P.M. and 9 P.M. During the summer months the reading of a wet-bulb thermometer is taken at these times. Instruments recording the maximum and minimum temperatures, and measuring the rainfall, are also used.

Besides our regular observations, records are made of casual meteorological phenomena, and the condition of farm crops, trees, etc., as affected by the weather or season.

Monthly and annual reports are sent to the headquarters of the signal service at Washington, D. C., and to the New England Meteorological Society.

During the summer months we have sent weekly weather crop reports to the latter society, and have furnished a partial monthly report for the use of the secretary of the State Board of Agriculture.

The weather during January and February was exceptionally mild, even more so than during 1889. Considerable difficulty was experienced in getting ice. In this vicinity none was cut until February, when it reached a thickness of from six to eight inches.

There was hardly enough snow for good sleighing at any time during the winter. A snow-storm on the 20th of February gave sleighing for two or three days, and one on the 6th of March gave fair sleighing until the 10th. The temperature for March was lower than for either of the preceding months.

The total snow fall for March is recorded as seventeen inches, but with one exception it disappeared soon after falling.

The last heavy frost, during the spring, occurred April 29. Light frosts were reported on the 17th and 23d of May.

The weather during the early part of the season was, on



the whole, favorable to the growth of farm crops. The first crop of hay was large, and most of it was secured in good condition during the dry weather preceding the heavy rain beginning July 24. The crop of rowen suffered somewhat on account of that drought, and other crops suffered to some extent. During the remainder of the growing season there was sufficient rain, most of the time an abundance.

Frost held off remarkably late, the first in the autumn occurring September 25, after which there was none until October 13.

The first trace of snow occurred November 11. There were 15.5 inches during December, with good sleighing most of the time.

The rainfall during the year was slightly above the average, and fairly distributed. The rains during April, June and November, however, were light, being less than two inches in each case.

The heaviest rain of the season occurred on the 24th, 25th and 26th of July, giving a rainfall of 4.65 inches.

From the 9th to the 15th of September it rained every day, giving 2.57 inches, and on the 17th of that month there was a fall of 1.50 inches. A storm on the 23d and 24th of October gave 2.30 inches.

During the year there were one hundred and fifty days recorded as "cloudy," seventy-one as "clear." The greatest number of cloudy days, seventeen, occurred in October, and the greatest number of clear days, nine, in November and December. In August there were but three clear days.

The prevailing wind during six months of the year was north-west. It was north-east during March, April and August, south-east during May and June, and south during July.

The mean annual temperature for the year,  $46.43^{\circ}$ , was about the average. The principal variations from the monthly average temperatures occurred in January, which has had a higher temperature during the period covered by the Amherst observation only in 1838, 1870 and 1880. February also was considerably warmer than usual. The average for December is the lowest since 1876.

The highest temperature during the year was  $92^{\circ}$ , occurring July 8; the lowest,  $-9.5^{\circ}$ , occurring March 7.

*Summary of Meteorological Observations, 1890.*

	TEMPERATURE, DEGREES FAHRENHEIT.							RELATIVE HUMIDITY, PER CT.			PRECIPITATION, INCHES.	
	7 A. M.	9 P. M.	Mean.	Maxi- mum.	Range.	Absolute Maxi- mum.	Date.	7 A. M.	9 P. M.	Mean.	Depth of Water.	Date of Greatest Fall.
January, . .	26.7	35.1	30.5	39.8	21.5	61.5	2d	-	-	-	2.61	15th-16th
February, . .	26.6	36.0	30.8	39.9	22.5	69.5	26th	-	-	-	4.01	8th
March, . .	25.1	35.6	30.0	38.9	21.6	59.5	12th	-	-	-	4.81	22d, 23d
April, . .	38.6	55.2	44.0	57.6	32.8	77.5	13th	-	-	-	1.64	4th
May, . .	51.6	64.9	56.4	67.6	44.7	79.0	14th	84.1	60.9	76.2	5.14	26th-27th
June, . .	60.2	73.2	64.6	76.3	53.1	88.5	30th	83.7	57.4	78.4	1.48	5th-6th
July, . .	63.6	77.0	68.1	79.7	56.2	92.0	8th	85.0	54.0	78.3	5.44	24th-26th
August, . .	62.5	74.3	66.3	76.6	57.2	86.0	4th, 6th	89.8	61.1	83.6	4.60	19th-20th
September, .	54.4	67.3	59.4	69.7	50.3	78.5	2d, 7th	93.4	68.8	89.0	5.28	17th
October, . .	42.5	55.1	47.4	56.8	39.3	76.0	1st	89.1	61.2	83.8	6.89	16th-17th
November, .	32.4	43.2	36.3	46.0	27.5	60.0	6th	-	-	-	1.24	17th
December, .	18.6	25.1	21.7	36.2	5.4	42.5	23d	-	-	-	3.18	26th
Sums, . .	502.8	642.0	557.2	685.1	432.1	858.5	-	625.1	363.4	469.2	46.32	-
Means, . .	41.90	53.50	46.43	57.09	36.01	71.54	-	87.52	60.57	81.55	3.86	-

*Miscellaneous Phenomena, — Dates.*

	Frost.	Snow.	Rain.	Thunder- storms.	Lunar Halos.
January, . .	4, 19, 23,	10, 11, 23, 31,	1, 5, 6, 10, 11, 12, 13, 15, 16, 20, 27, 30.	-	-
February, . .	7, 14,	2, 7, 10, 20,	4, 7, 8, 14, 17, 18, 24, 25, 28.	-	1.
March, . .	24,	3, 5, 6, 15, 19, 28, 29, 31,	1, 11, 14, 21, 22, 23, 25, 26, 28.	28,	45, 24.
April, . .	2, 3, 6, 8, 12, 16, 20, 21, 29.	-	4, 7, 8, 9, 25, 26, 27,	-	29.
May, . .	17, 23,	-	1, 3, 4, 5, 6, 10, 11, 14, 15, 16, 17, 20, 25, 27, 28.	14, 28,	-
June, . .	-	-	3, 4, 5, 6, 12, 13, 14, 15, 19.	5, 6,	-
July, . .	-	-	3, 4, 7, 15, 19, 24, 25, 26, 31.	7, 19, 26, 31,	-
August, . .	-	-	1, 9, 10, 12, 17, 18, 19, 20, 21, 22, 23, 26, 27, 30.	17, 19,	-
September, . .	25,	-	5, 6, 9, 10, 11, 12, 13, 14, 15, 17, 26.	17,	-
October, . .	13, 16, 22, 23,	-	4, 6, 7, 8, 10, 14, 16, 17, 19, 20, 23, 24, 25, 29, 30.	-	23, 25.
November, . .	1, 3, 4, 5, 6, 13, 14, 15, 21, 24, 26, 30.	-	2, 9, 11, 15, 17,	-	-
December, . .	2,	3, 5, 6, 26, 30,	3, 17, 18, 21,	-	16, 25.

C. A. GOESSMANN,  
*Director.*

## ANNUAL REPORT OF FRANK E. PAIGE,

TREASURER OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION,

*For the Year ending Dec. 31, 1890.*

## RECEIVED.

Cash from Dr. J. P. Lynde, balance of last year, . . . . .	\$15 00
Cash from State Treasurer, appropriation, . . . . .	10,000 00
Cash from farm, etc., . . . . .	1,422 07
Cash from fertilizer account, . . . . .	1,905 00
	<hr/> \$13,342 07

## EXPENDED.

Cash paid salaries, . . . . .	\$4,478 03
Cash paid laboratory supplies, . . . . .	1,213 01
Cash paid printing and office expenses, . . . . .	838 34
Cash paid farmer and farm labor, . . . . .	2,050 10
Cash paid farm stock and feed, . . . . .	1,278 96
Cash paid incidental expense, . . . . .	899 93
Cash paid construction and repairs, . . . . .	599 22
Cash paid expense of board of control, . . . . .	75 62
Cash paid fertilizer account, . . . . .	1,565 00
Cash on hand, . . . . .	343 86
	<hr/> \$13,342 07

SUMMARY OF THE PROPERTY OF THE MASSACHUSETTS  
STATE AGRICULTURAL EXPERIMENT STATION.*(Dec. 31, 1890.)*

Buildings, etc., . . . . .	\$30,702 00
Farm inventory (live stock, crops, etc.), . . . . .	2,299 45
Office furniture (chemical laboratory), . . . . .	1,456 75
Chemicals and chemical apparatus (chemical laboratory), . . . . .	2,605 95
Furniture, herbariums and library (agricultural and physiological laboratory), . . . . .	903 25
Instruments, apparatus, etc. (agricultural and physiological laboratory), . . . . .	822 10
Total of inventory, . . . . .	<hr/> \$38,789 50

BOSTON, MASS., Jan. 8, 1891.

This is to certify that I have examined the books and accounts of Frank E. Paige, Treasurer of the Massachusetts Agricultural Experiment Station, for the fiscal year ending Dec. 31, 1890, and find them correct, and all disbursements properly vouched for, with a balance of cash in treasury of three hundred forty-three dollars and eighty-six cents, which is shown to be in bank.

W. R. SESSIONS,  
Auditor.

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NINTH ANNUAL REPORT  
OF THE  
BOARD OF CONTROL  
OF THE  
STATE AGRICULTURAL EXPERIMENT  
STATION

AT  
AMHERST, MASS.

1891.

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BOSTON:  
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18 POST OFFICE SQUARE.  
1892.



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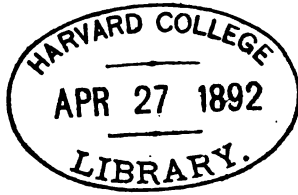
AMHERST, MASS.

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1892.



Hon. Sam. A. Green,  
Boston.

# Commonwealth of Massachusetts.

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OFFICE OF THE SECRETARY, BOSTON, Jan. 14, 1892.

HON. WILLIAM E. BARRETT, *Speaker of the House of Representatives.*

SIR:—I have the honor to transmit, for the use of the Legislature, the Ninth Annual Report of the Board of Control of the State Agricultural Experiment Station.

Very respectfully,

ISAAC H. EDGETT,

*Deputy Secretary.*



**Boston, Jan. 13, 1892.**

*To the Honorable Senate and House of Representatives.*

In accordance with chapter 212 of the Acts of 1882 I have the honor to present the Ninth Annual Report of the Board of Control of the State Agricultural Experiment Station.

**WM. R. SESSIONS,**

*Secretary.*

**MASSACHUSETTS STATE**  
**AGRICULTURAL EXPERIMENT STATION,**  
**AMHERST, MASS.**

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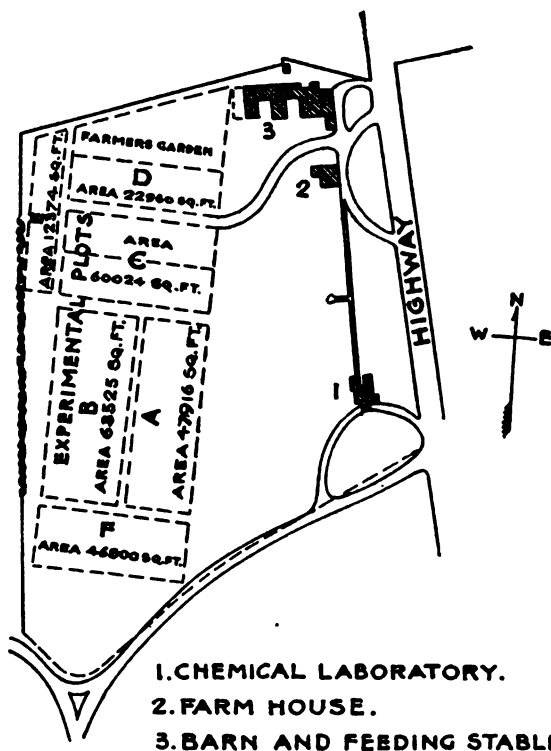
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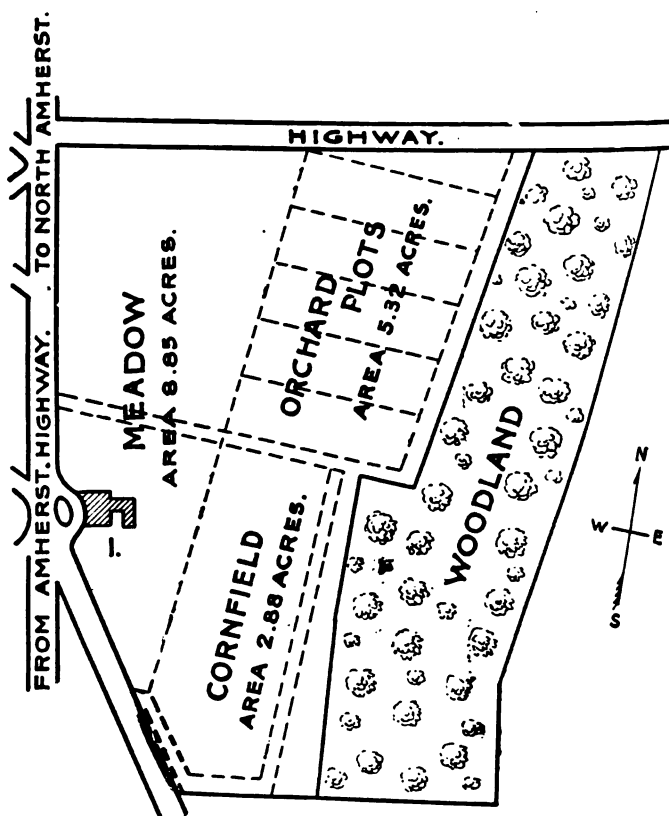
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· MAP OF LAND LEASED TO THE ·  
· MASSACHUSETTS EXPERIMENT STATION ·  
· FROM THE ·  
· AGRICULTURAL COLLEGE FARM ·  
· WEST OF THE HIGHWAY ·  
· AREA TAKEN · 17.72 ACRES ·



I. AGRICULTURAL & PHYSIOLOGICAL LABORATORY.

MAP OF LAND LEASED TO THE  
 MASSACHUSETTS EXPERIMENT STATION  
 FROM THE  
 AGRICULTURAL COLLEGE FARM  
 EAST OF THE HIGHWAY  
 AREA TAKEN 30.52 ACRES

NINTH ANNUAL REPORT OF THE DIRECTOR  
OF THE  
MASSACHUSETTS STATE AGRICULTURAL  
EXPERIMENT STATION,  
AMHERST, MASS.

---

*To the Honorable Board of Control.*

GENTLEMEN:—The past year has been a prosperous one in the history of the Massachusetts State Agricultural Experiment Station.

The buildings have suffered no injury from any exceptional source and are in a well-preserved state, considering their respective age and previous condition.

The construction of a new barn, for storing separately in a desirable manner the products of the different experimental plats, has filled a serious want.

A favorable season has aided materially in a successful termination of a variety of field experiments as well as in a satisfactory general management of the farm work.

The different lines of investigation presented from time to time for your consideration have received their due attention as far as circumstances have rendered practicable. The amount of work accomplished in the field, the barn and the chemical laboratory compares well with the results of previous years. The introduction of the vegetation house for the purpose of studying, under well-defined circumstances, the influence of special articles of plant food on the growth and character of plants, besides other intricate questions of vegetable physiology, has added an important feature to our resources of efficient methods of observation for the advancement of an economical production of farm crops.

Prof. J. E. Humphrey has continued his observations regarding various diseases of fruit-trees and garden crops. An interesting description of his investigation during the past year forms part of this report (Part II. 9).

The details of the work carried on during the past year, 1891, are reported upon subsequent pages in the following order:—



## PART I.

### ON FEEDING EXPERIMENTS—1891.

- I. FEEDING EXPERIMENTS WITH MILCH COWS (three).
- II. FEEDING EXPERIMENTS WITH STEERS.
- III. FEEDING EXPERIMENTS WITH LAMBS.
- IV. FEEDING EXPERIMENTS WITH PIGS (three).

#### I.

##### *Feeding Experiments with Milch Cows—1891.*

- 1. Feeding experiments with milch cows: Old-process linseed meal *vs.* gluten meal (Chicago).
- 2. Feeding experiment with milch cows: Gluten meal (Chicago) *vs.* cotton-seed meal and old-process linseed meal.
- 3. Summer feeding experiment with milch cows: Green feed,—vetch and oats, soja bean and fodder corn. Grain feed,—corn meal, gluten meal (Chicago), with dried brewers' grain *vs.* wheat bran.
- 4. Creamery record of the station for 1890 and 1891.
- 5. Fodder analyses and valuation of fodder.

## PART II.

### ON FIELD EXPERIMENTS, AND OBSERVATIONS IN VEGETABLE PHYSIOLOGY AND PATHOLOGY.

- 1. Effect of different kinds of nitrogen containing manurial substances on the yield of rye (Field A).
- 2. Experiments with prominent varieties of grasses and with grass mixtures to ascertain their comparative economical value under fairly corresponding circumstances (Field B).
- 3. Experiments with reputed fodder crops mostly new to our locality, and with a series of garden crops treated with different mixtures of commercial fertilizing ingredients (Field C).
- 4. Experiments with raising Stowell's evergreen sweet corn for ensilage (Field D).
- 5. Experiments with different commercial phosphates to study the economy of using natural phosphates or acidulated phosphates in farm practice (Field F).

6. Experiment with a Western variety of dent corn, Pride of the North, for ensilage (Field G).
7. Experiments with grass lands (meadows).
8. Report on general farm work in 1891.
9. Report of Prof. James Ellis Humphrey on plant diseases, etc., with observations in the field and in the vegetation house.

## PART III.

### SPECIAL WORK IN THE CHEMICAL LABORATORY.

#### I. Communication on commercial fertilizers :—

1. General introduction.
2. Laws for the regulation of the trade in commercial fertilizers.
3. List of licensed manufacturers.
4. Analyses of licensed fertilizers.
5. Analyses of commercial fertilizers and manurial substances sent on for examination.
6. Miscellaneous analyses.

#### II. Water analyses.

#### III. Compilation of analyses made at Amherst, Mass., of agricultural chemicals and refuse materials used for fertilizing purposes.

#### IV. Compilation of analyses made at Amherst, Mass., of fodder articles, fruits, sugar-producing plants, dairy products, etc.

### *Meteorological Observations.*

The periodical publications of the station have been as numerous as during previous years. The applications for copies of bulletins and annual reports are steadily increasing. Our supply of bulletins I to XXX and of annual reports I to VI is exhausted.

In concluding this communication it gives me pleasure to acknowledge the industry and faithful assistance of all parties associated with me in the task assigned. With sincere thanks for your kind support and indulgence allow me to sign,

Yours very respectfully,

C. A. GOESSMANN,

*Director of the Massachusetts State Agricultural Experiment Station.*



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**PART I.**

**ON**

**FEEDING EXPERIMENTS,**

**1891.**

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- I. FEEDING EXPERIMENTS WITH MILCH COWS (THREE).**
  - II. FEEDING EXPERIMENTS WITH STEERS.**
  - III. FEEDING EXPERIMENTS WITH LAMBS.**
  - IV. FEEDING EXPERIMENTS WITH PIGS (THREE).**
- 
-

I.

FEEDING EXPERIMENTS WITH MILCH COWS.

1891.

---

General introduction to our late feeding experiments with milch cows.

- I. Feeding experiment with milch cows: Old-process linseed meal *vs.* gluten meal (Chicago variety).
- II. Feeding experiment with milch cows: Gluten meal (Chicago variety) *vs.* cotton-seed meal and old-process linseed meal.
- III. Summer feeding experiment with milch cows: Green feed, — vetch and oats, soja bean and fodder corn. Grain feed, — corn meal, gluten meal (Chicago variety), with dried brewers' grain *vs.* wheat bran.
- IV. Creamery record of the station for 1890 and 1891, with a description of modes of analysis.
- V. Analysis of fodder and valuation of fodder.

*General Introduction.* — In summing up in our late annual report the principal results obtained in connection with a series of feeding experiments with milch cows, carried on from 1885 to 1889 at the Massachusetts State Agricultural Experiment Station, special attention was called to the fact that until quite recently our main object has been to compare the economical value of some of our most prominent current *home-raised coarse fodder articles* when used for dairy purposes. English hay, rowen (hay of second cut of upland meadows), dry fodder corn, corn stover, corn ensilage and several varieties of roots (sugar beets and carrots) were the fodder articles of that description used. They were fed as far as practicable under otherwise corresponding circumstances.

To attain this end it became necessary to use in all cases alike the same kinds and the same quantities of grain feed in compounding the daily diet of the cows on trial. The selec-

tion among the various kinds of grain feed for the daily diet was, for obvious reasons, confined to but a few, — viz., corn meal or corn and cob meal, wheat bran and gluten meal (Chicago variety). (See Eighth Annual Report, pages 12–15.) These articles were at any time, in sufficient quantity and of good quality, at our disposal; they all enjoyed a fair reputation of fitness for milk production.

Having made ourselves, by actual trial, to a certain degree familiar with the comparative feeding effect and the special economical merits of the above-stated coarse fodder articles under specified conditions, *it was decided to institute a new series of feeding experiments with milch cows for the special purpose of studying the feeding effect and the general economy of some of our most prominent concentrated commercial feed stuffs, as old and new process linseed meal, cotton-seed meal and gluten meal, when fed in equal weights in place of each other and in connection with the same kinds of fine and coarse fodder articles.*

The results of one experiment, which was planned to ascertain the comparative merits of old and new process linseed meal as constituents of the daily diet of milch cows, under otherwise corresponding circumstances, has been already published in Bulletin 38, and in our last annual report, pages 15–24.

Three more recent experiments of a similar character, with Chicago gluten meal and old-process linseed meal, with Chicago gluten meal and cotton-seed meal, and with dried brewers' grain and wheat bran, are reported within a few subsequent pages, marked 1, 2, 3.

### *1. Feeding Experiment with Milch Cows.*

Old-process linseed meal vs. gluten meal (Chicago variety), Oct. 21 to Dec. 31, 1889.

This feeding experiment was instituted as above intimated for the special purpose of comparing the effect of old-process linseed meal with that of gluten meal on the cost of feed and on the yield of milk, when fed in equal weights as substitutes of each other in connection with the same kinds and the same quantities of coarse and fine fodder articles. Six cows, grades, served in the trial; the observation lasted from ten to twelve weeks.

# 16 AGRICULTURAL EXPERIMENT STATION. [Jan.

## 1. History of Cows.

NAME.	Breed.	Age (Years).	Last Calf dropped.	Daily Yield of Milk at begin- ning of Trial (Quarts).	Number of Months on Trial.
Juno, .	Grade Ayrshire, .	7	June 22, 1889,	11-12	2½
Flora, .	Grade Durham, .	6	Dec. 22, 1888,	9-10	2½
Eva, .	Grade Jersey, .	10	Oct. 7, 1888,	7-8	2½
Elsie, .	Grade Holstein, .	7	Feb. 26, 1889,	7-8	2½
Jessie, .	Grade Jersey, .	6	Jan. 12, 1889,	8-9	2½
Annie, .	Grade Jersey, .	7	June 19, 1888,	8-9	2½

The cows thus far used in all our feeding experiments for the production of milk have been grades of more or less uncertain parentage. We secure them usually on the condition that they are new milch cows, from one to two weeks after calving when bought, and of fair milking quality, yielding from fifteen to sixteen quarts per day at this time. They serve usually in the trials until their daily yield of milk becomes unprofitable, from five to six quarts, when they are replaced by new milch cows.

## 2. Description of Fodder Articles.

The general character and chemical composition of the different fodder ingredients used in the preparation of the daily diet may be seen from the following statement:—

	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-pro- cess Lin- seed Meal.	Hay.
Moisture at 100° C., . . .	11.67	9.27	9.80	9.88	9.72
Dry matter, . . . . .	88.33	90.73	90.20	90.12	90.28
	100.00	100.00	100.00	100.00	100.00
<i>Analyses of Dry Matter.</i>					
Crude ash, . . . . .	1.89	7.47	1.25	7.39	6.43
“ cellulose, . . . . .	1.44	9.75	1.75	8.74	32.28
“ fat, . . . . .	4.44	5.48	7.00	7.24	2.49
“ protein, . . . . .	10.46	17.53	31.25	36.97	9.54
Non-nitrogenous matter, .	81.77	59.77	58.75	39.66	49.26
	100.00	100.00	100.00	100.00	100.00

*Fertilizing Constituents contained in the Various Fodder Articles used.*

	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-pro- cess Lin- seed Meal.	Hay.
Moisture at 100° C., . . .	11.67	9.27	9.80	9.88	9.72
Nitrogen, . . . . .	1.479	2.545	4.510	5.331	1.379
Phosphoric acid, . . . .	0.713	2.900	0.392	1.646	0.359
Potassium oxide, . . . .	0.490	1.637	0.049	1.162	1.572

*3. Mode of Feeding.*

The daily fodder rations contained per head throughout the entire experiment three and one-fourth pounds of corn meal and three and one-fourth pounds of wheat bran, with either three and one-fourth pounds of gluten meal (Chicago variety) or three and one-fourth pounds of old-process linseed meal as grain feed ration. A fair quality of English hay, first cut of upland meadows, served as the sole coarse feed during the entire experiment. The daily ration of hay was controlled by the appetite of each cow engaged in the trial. It varied from eighteen to twenty-two pounds per head in case of different animals.

One-half the above-stated grain feed ration was fed with some hay at the time of milking in the morning and the other half in a similar way during milking in the evening. The remainder of the hay was given at noon and after milking in the evening. Water was offered twice daily, as a rule, one and one-half to two hours after feeding the grain feed.

The daily fodder rations described farther on represent the *average composition* of the daily diet per head during the different succeeding feeding periods. The calculation of the cost of the daily fodder rations below stated is based on the contemporary local market price of the various fodder articles used in their combination.



# 18 AGRICULTURAL EXPERIMENT STATION. [Jan.

## *Local Market Cost of the Various Fodder Articles used from Oct. 21 to Dec. 31, 1889.*

	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-pro- cess Linseed Meal.	Hay.
Per 2,000 pounds, . . .	\$19 00	\$17 50	\$23 00	\$27 00	\$15 00
Per pound (cents), . . .	0.95	0.875	1.15	1.35	0.75

## *Commercial Value of the Essential Fertilizing Constituents contained in the Above Fodder Articles.*

Nitrogen, 17 cents; phosphoric acid, 6 cents; potassium oxide, 4½ cents.

Moisture at 100° C., . . .	11.67	9.27	9.80	9.88	9.72
Nitrogen, . . . . .	1.479	2.545	4.510	5.831	1.379
Phosphoric acid, . . . .	.713	2.900	0.892	1.646	0.359
Potassium oxide, . . . .	.430	1.637	0.049	1.162	1.572
Valuation per 2,000 pounds,	\$6 27	\$13 60	\$15 85	\$21 15	\$6 53

## *Obtainable Manurial Value (per Ton), allowing a Loss of 20 Per Cent. contained in the Milk sold.*

	\$5 02	\$10 88	\$12 68	\$16 92	\$5 22
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## *Net Cost of Above Fodder Articles per 2,000 Pounds (obtained by deducting the Obtainable 80 Per Cent. of Manurial Value from their Market Cost).*

	\$13 98	\$6 62	\$10 32	\$10 08	\$9 78
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## *Net Cost per Pound (Cents).*

	0.699	0.331	0.516	0.504	0.489
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## *Average Composition of the Daily Fodder Rations used during Different Periods of the Experiment.*

### I. AND II.

Corn meal, . . . . .	3.25 lbs.
Wheat bran, . . . . .	3.25 "
Gluten meal, . . . . .	3.25 "
Hay, . . . . .	19.50 "
Total cost, . . . . .	24.30 cts.
Net cost, . . . . .	14.64 "
Manurial value obtainable, . . . . .	9.66 "
Nutritive ratio, . . . . .	1:6.35

*Average Composition, etc. — Concluded.*

## III.

Corn meal, . . . . .	3.25 lbs.
Wheat bran, . . . . .	3.25 "
Old-process linseed meal, . . . . .	3.25 "
Hay, . . . . .	18.50 "
Total cost, . . . . .	24.18 cts.
Net cost, . . . . .	14.06 "
Manurial value obtainable, . . . . .	10.12 "
Nutritive ratio, . . . . .	1:5.73

*Summary of the Cost of the Daily Fodder Rations.*

	PERIODS.		
	I.	II.	III.
	Cents.	Cents.	Cents.
Market cost, . . . . .	24.30	24.30	24.18
Manurial value obtainable, . . . . .	9.66	9.66	10.12
Net cost, . . . . .	14.64	14.64	14.06

4. *Valuation of Feed.*

The commercial valuation of the feed stuffs used in the above-described fodder rations is based on their market price per ton of 2,000 pounds at Amherst during the time occupied by the experiment here under discussion, October, 1889, to January, 1890. The market cost of wheat bran, gluten meal and, in particular, of corn meal has since in an exceptional degree advanced, while that of old-process linseed meal and of English hay has remained materially the same. Accepting the above-stated market prices as well as the chemical analysis of the different fodder articles as the basis for our financial calculation we find that the market cost of the daily grain feed rations (periods I., II.), consisting of corn meal and wheat bran with gluten meal, three and one-fourth pounds each, amounts to 9.67 cents, while in case of a corresponding quantity of corn meal, wheat bran and old-process linseed meal it amounts to 10.32 cents, a difference of 0.63 cents in favor of the gluten meal containing daily grain feed ration.

Allowing on the other hand in our calculation the commercial value of 80 per cent. of the nitrogen, phosphoric acid and potassium oxide contained in the grain feed constituents of the different daily fodder rations as obtainable in form of the manurial refuse, we notice that the higher market price of the old-process linseed meal (\$27 per ton) as compared with that of the gluten meal (\$23 per ton), a difference of four dollars in favor of the latter, is practically offset by the higher commercial value of the manurial refuse obtained when feeding old-process linseed meal, pound for pound, in place of gluten meal in connection with an otherwise corresponding daily diet of milch cows. The net cost of the gluten meal containing daily grain feed ration (periods I., II.) amounts per head to 5.03 cents, while that of the old-process linseed meal containing grain feed portion of the daily fodder rations (period III.) amounts to 4.99 cents, a difference of 0.04 cents in favor of the latter, too small an amount to deserve serious consideration from a commercial stand-point.

*Average Quantity of Milk per Day (Quarts).*

[1 quart = 2.15 pounds.]

FEEDING PERIODS.	Juno.	Flora.	Eva.	Elsie.	Jessie.	Annie.
I., . . . .	11.63	9.87	7.37	7.70	8.37	8.06
II., . . . .	11.27	9.11	7.14	7.42	8.23	7.55
III., . . . .	9.67	8.64	6.28	7.07	7.87	6.90
Average, . .	10.85	9.21	7.27	7.39	8.16	7.50

An examination of the above-stated average daily yield of milk in case of different cows shows a gradual decline from period to period. The decline in the daily yield of milk of the second period, as compared with that of the first period, varies in case of different cows from .14 to .76 quarts and averages per head 0.4 quarts for the entire herd. The difference in the decline of the daily yield of milk, when substituting pound for pound old-process linseed meal for gluten meal in the daily diet (period III.), is as a rule more marked

and less uniform, as far as different animals are concerned, than will be noticed when comparing first and second feeding periods in the stated direction. The actual decline in average daily yield of milk when passing from II. into III. period varies in case of different cows from .35 to 1.6 quarts, and amounts to .71 quarts per head in case of the entire herd.

	I.*	II.†
Juno, . . . . .	11.63 — 9.67	10.85
Flora, . . . . .	9.87 — 8.64	9.21
Eva, . . . . .	7.89 — 6.28	6.93
Elsie, . . . . .	7.70 — 7.07	7.39
Jessie, . . . . .	8.37 — 7.87	8.15
Annie, . . . . .	8.06 — 6.90	7.50

\* Variations in daily production of milk during the entire feeding experiment (quarts).

† Average quantity of milk per day for the entire feeding experiment (quarts).

### *Analyses of Milk (Per Cent.).*

#### *Juno.*

	Oct. 15.	Dec. 4.	Dec. 17.	Dec. 24.	Dec. 31.
Solids, . . . . .	13.22	13.16	12.61	12.25	13.68
Fat, . . . . .	4.03	3.56	3.75	3.62	4.33
Solids not fat, . . . .	9.19	9.60	8.86	8.63	9.35

#### *Flora.*

	13.35	14.04	13.68	13.38	13.36
Solids, . . . . .	13.35	14.04	13.68	13.38	13.36
Fat, . . . . .	4.10	4.18	3.92	3.92	3.33
Solids not fat, . . . .	9.25	9.86	9.76	9.46	10.03

#### *Eva.*

	16.25	16.88	17.65	16.70	16.92
Solids, . . . . .	16.25	16.88	17.65	16.70	16.92
Fat, . . . . .	6.10	6.18	6.18	6.18	6.15
Solids not fat, . . . .	10.15	10.70	11.47	10.52	10.77

## 22 AGRICULTURAL EXPERIMENT STATION. [Jan.

### *Analyses of Milk (Per Cent.) — Concluded.*

#### *Elsie.*

	Oct. 15.	Dec. 4.	Dec. 17.	Dec. 24.	Dec. 31.
Solids, . . . .	12.82	13.42	12.55	12.80	13.00
Fat, . . . .	3.55	3.92	3.65	4.08	4.00
Solids not fat, . . . .	9.27	9.52	8.90	8.72	9.00

#### *Jessie.*

	Oct. 15.	Dec. 4.	Dec. 17.	Dec. 24.	Dec. 31.
Solids, . . . .	14.74	14.96	15.08	14.96	14.12
Fat, . . . .	5.33	5.46	5.40	5.32	4.90
Solids not fat, . . . .	9.41	9.50	9.68	9.64	9.22

#### *Annie.*

	Oct. 15.	Dec. 4.	Dec. 17.	Dec. 24.	Dec. 31.
Solids, . . . .	15.68	15.44	14.80	13.68	14.88
Fat, . . . .	5.18	5.24	5.29	3.77	5.11
Solids not fat, . . . .	10.50	10.20	9.51	9.91	9.77

### *Live Weight of Animals during the Feeding Periods (Pounds).*

FEEDING PERIODS.	NAME OF COW.					
	June.	Flora.	Eva.	Elsie.	Jessie.	Annie.
I, . . . .	1,064	980	1,086	1,200	868	954
II., . . . .	1,089	992	1,098	1,207	880	969
III., . . . .	1,070	1,000	1,092	1,220	888	981
Gain at close, . . . .	6	20	6	20	20	27

*Conclusions.* — The previously stated results of our inquiry into the comparative merits of gluten meal (Chicago variety) and of old-process linseed meal as constituents of the daily diet of milch cows lead us to the following conclusions: 1. The substitution of three and one-fourth pounds of gluten meal (Chicago variety) by the same weight of old-process linseed meal at stated local market prices, and under otherwise corresponding circumstances, raises the market cost of the daily fodder ration per head 0.65 cents. Taking

in both instances the obtainable manurial value (80 per cent.) into consideration, the old-process linseed meal proves, in our case, 0.04 cents cheaper than gluten meal. The higher manurial value of the old-process linseed meal as compared with our sample of gluten meal fairly equals the difference in the local market cost of both articles. 2. The Chicago gluten meal leads in our case the old-process linseed meal in every instance, as far as the nutritive effect of both is concerned. The difference is not great, yet worthy of special notice under stated market conditions. 3. The quality of the milk as far as its density is concerned shows no marked difference during the entire experiment.

## FEEDING RECORD.

I. *Junco*.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.				Amount of Dry Vegetable Matter in the Daily Ration (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.					
1899.									
Oct. 21 to Nov. 10, . . . . .	3.25	3.25	3.25	-	21.90	11.63	2.45	1:6.51	1,064
Nov. 13 to Dec. 3, . . . . .	3.25	3.25	3.25	-	21.81	11.27	2.52	1:6.51	1,089
Dec. 11 to Dec. 31, . . . . .	3.25	3.25	-	3.25	18.96	9.67	2.67	1:5.76	1,070
2. Flora.									
Oct. 21 to Nov. 10, . . . . .	3.25	3.25	3.25	-	17.90	9.87	2.52	1:6.25	980
Nov. 13 to Dec. 3, . . . . .	3.25	3.25	3.25	-	18.86	9.11	2.83	1:6.31	992
Dec. 11 to Dec. 31, . . . . .	3.25	3.25	-	3.25	19.43	8.64	3.04	1:5.79	1,000
3. Eva.									
Oct. 21 to Nov. 10, . . . . .	3.25	3.25	3.25	-	18.86	7.89	3.49	1:6.31	1,086
Nov. 13 to Dec. 3, . . . . .	3.25	3.25	3.25	-	19.71	7.14	3.72	1:6.87	1,098
Dec. 11 to Dec. 31, . . . . .	3.25	3.25	-	3.25	18.19	6.28	4.00	1:5.70	1,092

4. *Elsie.*

Oct. 21 to Nov. 10,	.	.	.	8.25	3.25	3.25	19.33	25.83	7.70	3.35	1:6.34	1,200
Nov. 13 to Dec. 3,	.	.	.	3.25	3.25	—	18.95	25.86	7.42	3.49	1:6.32	1,207
Dec. 11 to Dec. 31,	.	.	.	3.25	—	3.25	17.93	24.92	7.07	3.52	1:5.68	1,220

5. *Jessie.*

Oct. 21 to Nov. 10,	.	.	.	8.25	3.25	—	19.43	26.28	8.37	3.14	1:6.35	868
Nov. 13 to Dec. 3,	.	.	.	3.25	3.25	—	19.62	26.45	8.23	3.21	1:6.36	880
Dec. 11 to Dec. 31,	.	.	.	3.25	—	3.25	18.40	25.37	7.87	3.22	1:5.73	888

6. *Annie.*

Oct. 21 to Nov. 10,	.	.	.	3.25	3.25	—	17.62	24.65	8.06	3.06	1:6.24	954
Nov. 13 to Dec. 3,	.	.	.	3.25	3.25	—	17.95	24.95	7.55	3.30	1:6.25	969
Dec. 11 to Dec. 31,	.	.	.	3.25	—	3.25	17.69	24.70	6.90	3.58	1:5.66	981



## TOTAL COST OF FEED PER QUART OF MILK.

*June.*

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed.	Total Amount of Gluten Meal consumed.	Total Amount of Old-process Linseed Meal consumed.	Total Amount of Wheat Bran consumed.	Total Amount of Hay consumed.	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents)
1899.									
Oct. 21 to Nov. 10,	244.19	11.63	68.25	68.25	-	68.25	460.00	\$5.48	2.24
Nov. 13 to Dec. 3,	236.74	11.27	68.25	68.25	-	68.25	458.00	5.47	2.31
Dec. 11 to Dec. 31,	203.02	9.67	68.25	-	68.25	68.25	398.00	5.16	2.54

*Flora.*

Oct. 21 to Nov. 10,	207.21	9.87	68.25	68.25	-	68.25	376.00	\$4.85	2.34
Nov. 13 to Dec. 3,	191.28	9.11	68.25	68.25	-	68.25	396.00	5.00	2.61
Dec. 11 to Dec. 31,	181.50	8.64	68.25	-	68.25	68.25	408.00	5.23	2.88

*Eva.*

Oct. 21 to Nov. 10,	155.23	7.39	68.25	68.25	-	68.25	396.00	\$5.00	3.22
Nov. 13 to Dec. 3,	149.88	7.14	68.25	68.25	-	68.25	414.00	5.14	3.43
Dec. 11 to Dec. 31,	131.86	6.28	68.25	-	68.25	68.25	382.00	5.04	3.82

*Elsie.*

Oct. 21 to Nov. 10,	.	.	.	161.63	7.70	68.25	68.25	-	68.25	406.00	\$5 08	3.14
Nov. 13 to Dec. 3,	.	.	.	135.81	7.42	68.25	68.25	-	68.25	398.00	5 02	3.22
Dec. 11 to Dec. 31,	.	.	.	148.49	7.07	68.25	-	68.25	68.25	376.50	4 99	3.36

*Jessie.*

Oct. 21 to Nov. 10,	.	.	.	175.81	8.37	68.25	68.25	-	68.25	408.00	\$5 09	2.90
Nov. 13 to Dec. 3,	.	.	.	172.91	8.23	68.25	68.25	-	68.25	412.00	5 12	2.96
Dec. 11 to Dec. 31,	.	.	.	165.35	7.87	68.25	68.25	68.25	-	386.50	5 07	3.08

*Annie.*

Oct. 21 to Nov. 10,	.	.	.	169.30	8.06	68.25	68.25	-	68.25	370.00	\$4 81	2.84
Nov. 13 to Dec. 3,	.	.	.	158.60	7.55	68.25	68.25	-	68.25	374.00	4 84	3.05
Dec. 11 to Dec. 31,	.	.	.	145.00	6.90	68.25	68.25	68.25	-	371.50	4 96	3.42

## 28 AGRICULTURAL EXPERIMENT STATION. [Jan.

## NET COST OF MILK AND MANURIAL VALUE OF FEED.

*June.*

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
1889.					Cents.	Pounds.
Oct. 21 to Nov. 10, .	\$5 48	\$2 72	\$2 18	\$3 30	1.35	1,085
Nov. 13 to Dec. 3, .	5 47	2 71	2 17	3 30	1.39	1,095
Dec. 11 to Dec. 31, .	5 16	2 69	2 15	3 01	1.48	1,034

*Flora.*

Oct. 21 to Nov. 10, .	\$4 85	\$2 45	\$1 96	\$2 89	1.39	980
Nov. 13 to Dec. 3, .	5 00	2 51	2 01	2 99	1.56	990
Dec. 11 to Dec. 31, .	5 23	2 72	2 18	3 05	1.68	1,015

*Eva.*

Oct. 21 to Nov. 10, .	\$5 00	\$2 51	\$2 01	\$2 99	1.93	1,085
Nov. 13 to Dec. 3, .	5 14	2 57	2 06	3 08	2.05	1,118
Dec. 11 to Dec. 31, .	5 04	2 63	2 10	2 94	2.23	1,098

*Elsie.*

Oct. 21 to Nov. 10, .	\$5 08	\$2 50	\$2 00	\$3 08	1.85	1,200
Nov. 13 to Dec. 3, .	5 02	2 52	2 02	3 00	1.93	1,200
Dec. 11 to Dec. 31, .	4 99	2 62	2 10	2 89	1.95	1,220

*Jessie.*

Oct. 21 to Nov. 10, .	\$5 09	\$2 51	\$2 01	\$3 08	1.75	865
Nov. 13 to Dec. 3, .	5 12	2 53	2 02	3 10	1.79	880
Dec. 11 to Dec. 31, .	5 07	2 65	2 12	2 95	1.79	875

*Annie.*

Oct. 21 to Nov. 10, .	\$4 81	\$2 39	\$1 91	\$2 90	1.71	965
Nov. 13 to Dec. 3, .	4 84	2 40	1 92	2 92	1.84	980
Dec. 11 to Dec. 31, .	4 96	2 61	2 09	2 87	1.98	983

*Analyses of Fodder Articles used in the Experiment.**Corn Meal (Average).*

1889-1890.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	11.67	233.40	-	-	1 : 9.65
Dry matter, . . . . .	88.33	1,766.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .					
“ cellulose, . . . . .	1.89	37.80	-	-	
“ fat, . . . . .	1.44	28.80	9.79	34	
“ protein (nitrogenous matter), . . . . .	4.44	88.80	67.49	76	
Non-nitrogenous extract matter, . . . . .	10.46	209.20	177.82	85	
	81.77	1,635.40	1,537.28	94	
	100.00	2,000.00	1,792.38	-	

*Gluten Meal.*

1889-1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . . .	9.80	186.00	-	-	1 : 2.60
Dry matter, . . . . .	90.20	1,804.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.25	25.00	-	-	
“ cellulose, . . . . .	1.75	35.00	11.90	34	
“ fat, . . . . .	7.00	140.00	106.40	76	
“ protein (nitrogenous matter), . . . . .	31.25	625.00	531.25	85	
Non-nitrogenous extract matter, . . . . .	58.75	1,175.00	1,104.50	94	
	100.00	2,000.00	1,754.05	-	

*Old-process Linseed Meal (Average).*

1889-1890.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	9.88	197.60	-	-	1:1.70
Dry matter, . . . . .	90.12	1,802.40	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	7.39	147.80	-	-	
“ cellulose, . . . . .	8.74	174.80	45.45	26	
“ fat, . . . . .	7.24	144.80	131.77	91	
“ protein (nitrogenous matter), . . . . .	36.97	739.40	643.28	87	
Non-nitrogenous extract matter, . . . . .	39.66	793.20	721.81	91	
	100.00	2,000.00	1,542.31	-	

*Hay (Average).*

1889-1890.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	9.72	194.40	-	-	1:9.68
Dry matter, . . . . .	90.28	1,805.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.43	128.60	-	-	
“ cellulose, . . . . .	32.28	645.60	374.45	58	
“ fat, . . . . .	2.49	49.80	22.91	46	
“ protein (nitrogenous matter), . . . . .	9.54	190.80	108.76	57	
Non-nitrogenous extract matter, . . . . .	49.26	985.20	620.68	63	
	100.00	2,000.00	126.80	-	

## 2. *Feeding Experiment with Milch Cows.*

Gluten meal (Chicago variety) vs. cotton-seed meal and old-process linseed meal, November, 1890, to June 1891.

Below are briefly recorded the results of observations with cotton-seed meal and old-process linseed meal when fed as substitutes for gluten meal (Chicago variety) in an otherwise corresponding daily diet of milch cows. The experiment was instituted, as has been intimated above, mainly for the purpose of comparing the effect of cotton-seed meal and old-process linseed meal with that of gluten meal (Chicago variety) on the cost of the feed consumed and on the quantity and the quality of the milk produced, when fed each in equal weight as an ingredient of an otherwise corresponding daily diet of milch cows.

### 1. *History of Cows.*

Nine cows, grades of various descriptions and of different milking periods, served in the trial.

NAME OF COW.	Breed.	Age (Years).	Last Calf dropped.	Daily Yield of Milk at beginning of Trial (Quarts).	Number of Months on Trial.
1. Jessie, . .	Grade Jersey, .	7	Jan. 12, 1889,	6-7	5-6
2. Pearl, . .	Native, . . .	6	Aug. 8, 1890,	10-11	7
3. Pink, . .	Native, . . .	7	Jan. 23, 1890,	7-8	7
4. Roxy, . .	Grade Ayrshire,	7	Feb. 5, 1890,	6-7	2½
5. Buttercup, .	Grade Ayrshire,	5	Jan. 2, 1891,	13-14	4
6. Nancy, . .	Native, . . .	8	March 16, 1890,	8-9	4
7. Clarissa, .	Grade Durham,	7	March 18, 1891,	9-10	2
8. Juno, . .	Grade Ayrshire,	7	June 22, 1889,	7-8	3
3. Favorite, .	Grade Durham,	6	Feb. 20, 1891,	11-12	3

### 2. *Description of Fodder Articles.*

The daily fodder rations contained per head throughout the entire experiment, as fine or grain feed, three pounds of corn meal and three pounds of wheat bran; to these were added for stated reasons at different stages of the observation, per head, either three pounds of gluten meal, or three pounds of old-process linseed meal, or three pounds of cotton-seed meal to complete the daily ration of grain or fine feed.

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The general character of the various kinds of grain feed used in the daily diet may be seen from the following analyses of the different articles of grain feed used : —

	Corn Meal.	Wheat Bran.	Cotton-seed Meal.	Old-process Linseed Meal.	Gluten Meal.
Moisture at 100° C., . . .	13.26	12.11	9.77	8.72	10.90
Dry matter, . . . . .	86.74	87.89	90.23	91.28	89.10
	100.00	100.00	100.00	100.00	100.00
<i>Analyses of Dry Matter.</i>					
Crude ash, . . . . .	1.72	7.40	8.18	5.96	1.02
“ cellulose, . . . . .	2.28	12.17	7.74	8.23	1.28
“ fat, . . . . .	4.90	5.04	11.93	9.87	7.36
“ protein, . . . . .	12.94	18.48	44.41	36.19	34.79
Non-nitrogenous matter, .	78.16	56.91	28.34	39.75	55.55
	100.00	100.00	100.00	100.00	100.00

### *Fertilizing Constituents of the Above Fodder Articles.*

Nitrogen, 15 cents per pound; phosphoric acid, 5½ cents; potassium oxide, 4½ cents.

	Corn Meal.	Wheat Bran.	Cotton-seed Meal.	Old-process Linseed Meal.	Gluten Meal.
Moisture, . . . . .	13.26	12.11	9.77	8.72	10.90
Nitrogen, . . . . .	1.796	2.599	6.412	5.285	4.959
Phosphoric acid, . . . .	.707	2.845	2.333	1.780	.425
Potassium oxide, . . . .	.435	1.625	1.723	1.214	.045
Valuation per 2,000 pounds,	\$6 56	\$12 39	\$23 36	\$18 90	\$15 38

The coarse feed used in compounding the daily diet in this connection consisted either of nothing but rowen, — hay of second cut of upland meadows, — or of rowen and a mixed ensilage, consisting of equal weights of green fodder corn and of green soja bean, or of nothing but corn stover. The same variety of dent corn, “Pride of the North,” furnished the green fodder corn for the mixed ensilage and for the corn stover. The corn stover was obtained from the fully matured corn, while the corn used for the mixed ensilage had reached the stage of growth when the kernels begin to glaze.

The soja bean when used for ensilage had finished its growth and showed a liberal formation of seed pods. In both instances the entire plant was cut a few inches above ground.

The corn, — stalks, ears and leaves, — was reduced to pieces of from one to one and one-half inches in length, and the soja bean, — entire plant, — being still soft and succulent in the stated period of growth, was merely cut into two or three pieces. Both plants thus prepared were subsequently filled alternately, in layers one foot in thickness, into a silo. The filling of the silo was carried on as fast as the material could be conveniently secured. Each layer was carefully packed down and the whole finally covered with layers of tar paper and matched boards. The latter were held in place by barrels filled with sand. The silo was filled at the beginning of September, 1890, and opened for use during the succeeding January.

The mixed ensilage thus produced was of a yellowish green color, and less acid than a clear corn ensilage obtained from the same lot of fodder corn treated in the same manner and at the same time in an adjoining silo. The influence which in our case an addition of an equal weight of a nearly matured soja bean exerts on the composition of corn ensilage will be seen from a comparison of the following analyses of the two kinds of ensilage, No. 1 and No. 2.

The clear corn ensilage, No. 1, was obtained from the same lot of fodder corn which served for the production of the above-described mixed ensilage, No. 2. The silos were in both cases filled in the same way, and as far as practicable at the same time. They were of a corresponding size and contained fairly even quantities of vegetable matter. Both were opened for general use at about the same time, four months after filling. The samples that served for the analyses represent in each case the average of the ensilage obtained by cutting in a vertical direction through the contents of each silo.



*Analyses of Dry Matter.*

	No. 1. Corn Ensilage.	No. 2. Corn and Soja Bean Ensilage.
	Per Cent.	Per Cent.
Crude ash, . . . . .	6.73	11.04
" cellulose, . . . . .	26.90	27.84
" fat, . . . . .	3.27	5.35
" protein, . . . . .	8.97	15.27
Non-nitrogenous matter, . . . . .	54.13	40.50
	100.00	100.00

The composition of the dry vegetable matter of the mixed ensilage, No. 2, compares well with that of a medium quality of red clover hay.

The successful cultivation of the soja bean upon the fields of the Massachusetts State Agricultural Experiment Station has been repeatedly pointed out in previous annual reports. The superior feeding effect of green soja bean as a coarse fodder constituent in the diet of milch cows has been shown in our summer feeding experiments of 1890. (See Eighth Annual Report, pages 39 to 54.) Our experience this year confirms our previous statement. The high economical value of this reputed fodder crop finds again a striking illustration in the experiment reported in detail upon some succeeding pages.

The general character of the different coarse fodder articles used on this occasion will be seen from the subsequent statement.

FODDER ANALYSES OF THE DIFFERENT COARSE FODDER ARTICLES USED.	Rowen.	Corn and Soja Bean En- silage.	Corn Stover.
Moisture at 100° C., . . . . .	13.90	71.03	19.89
Dry matter, . . . . .	86.10	28.97	80.11
	100.00	100.00	100.00
<i>Analyses of Dry Matter.</i>	8.28	11.04	6.33
Crude ash, . . . . .	28.88	27.84	34.59
" cellulose, . . . . .	3.91	5.35	1.28
" fat, . . . . .	13.45	15.27	5.74
" protein, . . . . .	45.48	40.50	52.06
Non-nitrogenous extract matter, . . . . .	100.00	100.00	100.00

*Fertilizing Constituents.*

Nitrogen, 15 cents per pound; phosphoric acid, 5½ cents; potassium oxide, 4½ cents.

MANURIAL CONSTITUENTS IN THE ABOVE-STATED COARSE FEED STUFFS.	Rowen.	Corn and Soja Bean En- silage.	Corn Stover.
Moisture, . . . . .	13.90	71.03	19.89
Nitrogen, . . . . .	1.853	.708	.735
Phosphoric acid, . . . . .	.464	.420	.259
Potassium oxide, . . . . .	1.966	.444	1.235
Valuation per 2,000 pounds, . . .	\$7 84	\$2 98	\$3 60

*3. Mode of Feeding.*

The daily grain feed ration contained per head throughout the entire experiment three pounds of corn meal and three pounds of wheat bran. To these were added, per head, at different stages of our observation, either three pounds of gluten meal, or three pounds of old-process linseed meal, or three pounds of cotton-seed meal, to complete the grain feed part of the daily diet. One-half of the grain feed was fed with some of the coarse feed at the time of milking in the morning and the other half in a similar way during milking in the evening. The remainder of the coarse fodder was given at noon and after milking in the evening.

The consumption of the coarse fodder constituents of daily diet, as far as quantity is concerned, was in most instances controlled by the appetite of each animal. To satisfy the latter, a small excess was offered and the remaining portion subsequently weighed back. This practice was adopted, in particular, in case of rowen when fed alone as coarse feed, and in case of mixed ensilage and of corn stover. Five pounds of rowen, however, were always fed per day to each cow whenever the mixed ensilage of corn and soja bean formed a prominent part of their daily diet. The daily fodder rations, which are described below in detail, represent the *average composition* of the daily diet used, per head, during the different succeeding feeding periods.

The subsequent record of the cost of the different fodder ingredients used in the daily fodder ration can assist in recognizing the basis for our calculations of the cost of the latter.

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## Local Market Cost of the Various Fodder Articles used from November, 1890, to June, 1891.

	Corn Meal.	Wheat Bran.	Cotton-seed Meal.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn and Hops Bean Mealage.	Corn Stover.
Per 2,000 pounds, . . .	\$28 00	\$25 00	\$28 00	\$26 00	\$28 00	\$15 00	\$3 50	\$5 00
Per pound (cents), . . .	1.4	1.25	1.4	1.3	1.4	0.75	0.175	0.25

## Commercial Value of the Essential Fertilizing Constituents of the Above Fodder Articles.

Nitrogen, 15 cents; phosphoric acid, 5½ cents; potassium oxide, 4½ cents per pound.

Moisture, . . . . .	13.26	12.11	9.77	8.72	10.90	13.90	71.03	19.89
Nitrogen, . . . . .	1.796	2.599	6.412	5.285	4.959	1.853	.708	.735
Phosphoric acid, . . .	.707	2.845	2.333	1.780	.426	.464	.430	.250
Potassium oxide, . . .	.435	1.625	1.723	1.214	.045	1.906	.444	1.325
Valuation per 2,000 pounds,	\$6 56	\$12 39	\$23 36	\$18 90	\$15 88	\$7 84	\$2 96	\$3 60

## Obtainable Manurial Value (per Ton), allowing a Loss of 20 Per Cent. contained in the Milk sold.

	\$5 25	\$9 91	\$18 60	\$15 12	\$12 30	\$6 27	\$2 38	\$2 88
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## Net Cost of Above Fodder Articles per 2,000 Pounds (obtained by deducting the Obtainable 80 Per Cent. of Manurial Value from their Market Cost).

	\$22 75	\$15 09	\$9 81	\$10 88	\$15 70	\$8 73	\$1 13	\$2 12
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## Net Cost per Pound (Cents).

	1.14	0.75	0.465	0.54	0.78	0.44	0.056	0.106
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## Average Composition of the Principal Daily Fodder Rations used at Different Periods of the Experiment.

I.		II.	
Corn meal (pounds), . . .	3.00	Corn meal (pounds), . . .	3.00
Wheat bran, . . . . .	3.00	Wheat bran, . . . . .	3.00
Cotton-seed meal, . . . .	3.00	Gluten meal, . . . . .	3.00
Rowen, . . . . .	20.00	Rowen, . . . . .	17.50
Total cost (cents), . . .	27.15	Total cost (cents), . . .	25.28
Net cost, . . . . .	15.81	Net cost, . . . . .	15.68
Manurial value obtainable, .	11.34	Manurial value obtainable, .	9.60
Nutritive ratio, . . . . .	1:4.60	Nutritive ratio, . . . . .	1:6.13

*Average Composition, etc. — Concluded.*

III.		IV.	
Corn meal (pounds),	3.00	Corn meal (pounds),	3.00
Wheat bran,	3.00	Wheat bran,	3.00
Old-process linseed meal,	3.00	Cotton-seed meal,	3.00
Rowen,	17.40	Rowen,	5.00
Total cost (cents),	24.90	Corn and soja bean ensilage,	42.15
Net cost,	14.91	Total cost (cents),	23.28
Manurial value obtainable,	9.99	Net cost,	11.62
Nutritive ratio,	1:4.83	Manurial value obtainable,	11.66
		Nutritive ratio,	1:4.17
V.		VI.	
Corn meal (pounds),	3.00	Corn meal (pounds),	3.00
Wheat bran,	3.00	Wheat bran,	3.00
Gluten meal,	3.00	Gluten meal,	3.00
Rowen,	5.00	Corn stover,	13.90
Corn and soja bean ensilage,	46.15	Total cost (cents),	15.63
Total cost (cents),	23.98	Net cost,	9.52
Net cost,	12.80	Manurial value obtainable,	6.11
Manurial value obtainable,	11.18	Nutritive ratio,	1:6.74
Nutritive ratio,	1:4.70		
VII.		VIII.	
Corn meal (pounds),	3.00	Corn meal (pounds),	3.00
Wheat bran,	3.00	Wheat bran,	3.00
Cotton-seed meal,	3.00	Cotton-seed meal,	3.00
Corn stover,	14.00	Rowen,	17.60
Total cost (cents),	15.65	Total cost (cents),	25.35
Net cost,	8.57	Net cost,	14.77
Manurial value obtainable,	7.08	Manurial value obtainable,	10.58
Nutritive ratio,	1:5.66	Nutritive ratio,	1:4.49
IX.			
Corn meal (pounds),	.	.	3.00
Wheat bran,	.	.	3.00
Gluten meal,	.	.	3.00
Rowen,	.	.	17.40
Total cost (cents),	.	.	25.20
Net cost,	.	.	15.63
Manurial value obtainable,	.	.	9.57
Nutritive ratio,	.	.	1:5.12

*Summary of the Cost of the Daily Fodder Rations (Cents).*

	PERIODS.								
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Market cost, .	27.15	25.28	24.90	23.28	23.98	15.63	15.65	25.35	25.20
Manurial value obtainable, .	11.34	9.60	9.99	11.66	11.18	6.11	7.08	10.58	9.57
Net cost, .	15.81	15.68	14.91	11.62	12.80	9.52	8.57	14.77	15.63

*4. On Valuation of Feed.*

The commercial valuation of the feed adopted in this report is based on the contemporary local market cost (November, 1890, to May, 1891) of the different fodder articles used, *i. e.*, their retail selling price at Amherst per ton. The market price of the coarse fodder constituents of the daily diet, as rowen, fodder corn, corn ensilage, soja beans and corn stover, is the same as during the preceding year for the same period, November, 1889, to May, 1890, while that of most of the grain feed constituents of the daily diet, as corn meal, wheat bran, gluten meal and cotton-seed meal, is exceptionally high as compared with that during the preceding year for corresponding months. Old-process linseed meal alone had suffered a slight reduction, one dollar per ton.

The changes in their market price were as follows:—

*Local Market Price per Ton of 2,000 Pounds at Amherst, Mass.*

	November, 1889, to June, 1890.	November, 1890, to June, 1891.
Corn meal, . . . . .	\$19 00	\$28 00
Wheat bran, . . . . .	17 50	25 00
Cotton-seed meal, . . . . .	26 00	28 00
Old-process linseed meal, . . . . .	27 00	26 00
Gluten meal (Chicago), . . . . .	24 50	28 00
Rowen, . . . . .	15 00	15 00
Corn and soja bean ensilage, . . . . .	3 50	3 50
Corn stover, . . . . .	5 00	5 00

The above-stated change in the market cost of corn meal, wheat bran, gluten meal and cotton-seed meal affects very materially the cost of the daily diet as compared with that of the preceding year. The daily *grain feed rations* which contain gluten meal as an ingredient (II., V., VI., IX.) are 3.32 cents higher than they would have been during the preceding year for the corresponding months; those which contain cotton-seed meal (I., IV., VII., VIII.) are 2.85 cents higher, and that which contains old-process linseed meal (III.) is 2.40 cents higher. This increase in cost is largely due to the exceptional high price of corn meal and wheat bran.

The substitution of gluten meal or of cotton-seed meal by old-process linseed meal, three pounds in each case, causes a reduction of but 0.3 cents in the market cost of the grain feed portion of the daily diet per head. *The market cost of the daily grain feed rations used per head during the entire experiment varies only from 11.85 cents to 12.15 cents, a difference of 0.3 cents.* Allowing, however, a proper recognition of the commercial value of the essential manurial substances, nitrogen, phosphoric acid and potassium oxide, contained in each of the grain feed constituents of the daily fodder rations, *we find in our case that the net cost of the cotton-seed meal containing daily grain feed rations (I.) amounts to 7.07 cents, while that of the old-process linseed meal containing daily grain feed rations (II.) is 7.29 cents, and that of gluten meal containing fine feed rations (III.) is 8.01 cents, a difference respectively of 0.22 to 0.94 cents per head.* This difference in net cost is due to the higher manurial value of cotton-seed meal and of old-process linseed meal as compared with gluten meal at stated market prices.

The choice of different coarse fodder articles in the daily diet exerts a much greater influence on the market cost of the latter than that of the different kinds of grain feed. The market cost of the coarse fodder portion of the daily diet averages 13.5 cents in case rowen alone (eighteen pounds) serves as coarse feed; it averages 11.5 cents in case forty-four pounds of mixed ensilage and five pounds of rowen are daily fed; and it amounts to from 4 to 4½ cents in case from sixteen to eighteen pounds of corn stover are

used per day for that purpose. These facts find their expression in the above-stated market cost of the nine complete daily fodder rations used during the trial. The market cost of the complete daily fodder rations I., II., III., VIII., IX., containing rowen, averages 25.55 cents; rations IV., V., containing mixed ensilage with rowen, average 23.63 cents; and rations VI., VII., containing corn stover as coarse feed, average 15.64 cents. *The difference in the market cost of the above-described nine daily fodder rations, caused by the use of different coarse fodder constituents, rises in some instances as high as 9.91 cents.* This sum, it will be noticed, is three times as large as the difference due to an exceptional rise in the market cost of the grain feed portion of the various daily fodder rations used, accepting the ruling local market prices of feed stuff at the close of 1889 and of 1890 as the basis of our valuation.

Taking the manurial value of the different coarse fodder constituents used into consideration, we find the difference of their *net cost* not less striking than has been shown above to be the case in regard to their *market cost*.

	Market Cost.	Net Cost.	Manurial Value.
	Cents.	Cents.	Cents.
Rowen, 18 pounds, . . . . .	13.5	7.92	5.57
Mixed ensilage, 44 pounds, rowen, 5 pounds, . . . . .	11.45	4.66	6.79
Corn stover, 18 pounds, . . . . .	4.50	1.91	2.59

The high market price of two of our most prominent home-raised coarse fodder articles, first and second cut of upland meadow, — English hay and rowen, — affects seriously the degree of our financial results in the production of milk, as far as the cost of feed is concerned. We are in need of a cheaper source of supply of coarse fodder substances than a considerable proportion of our grass lands, pastures and meadows in their present state of productiveness can claim to give. More satisfactory results can be obtained, no doubt, in many cases by turning indifferently yielding dry grass lands, if at all capable of higher cultivation, to account for the

production of some other suitable fodder crop than grasses. The good services of dry fodder corn, corn stover and a good corn ensilage, for a more economical production of milk, are deservedly from day to day more generally recognized. However gratifying this fact may be considered, it is not advisable, in the light of past experience, in a general farm management to raise one fodder crop at the exclusion of all others, however lucrative at the time this practice may prove; such a course can at best only offer a temporary relief. The introduction of a greater variety, in particular, of annual reputed fodder-crops promises a more permanent improvement in fodder supply. Such a course, wherever adopted, has not only resulted in cheapening the production of milk and beef, but has proved to be a most economical way to raise the general productiveness of farm lands to a higher standard.

Our local experience with a variety of annual leguminous fodder crops, as vetches, serradella and soja bean, has been very encouraging. The satisfactory results obtained in previous years are fully confirmed during the present season, when a mixed crop of vetch and oats and soja bean has served as the principal coarse fodder for milk production from the middle of June to the beginning of September.

#### 5. Average Quantity of Milk per Day (Quarts).

	FEEDING PERIODS.								
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
1. Jessie, . . . .	6.77	5.30	5.70	7.54	8.47	6.80	5.50	-	-
2. Pearl, . . . .	10.74	10.28	10.84	-	12.19	9.07	7.34	9.19	9.24
3. Pink, . . . .	7.55	7.42	-	8.07	8.80	7.05	6.56	7.48	7.63
4. Roxy, . . . .	6.87	5.64	5.25	-	-	-	-	-	-
5. Buttercup, . . . .	-	-	-	13.36	13.31	10.66	9.31	9.45	8.68
6. Nancy, . . . .	8.34	7.68	7.49	8.31	8.54	-	-	-	-
7. Clarissa, . . . .	-	-	-	-	-	-	9.47	10.04	11.37
8. Juno, . . . .	7.29	6.70	6.45	7.50	-	-	-	-	-
9. Favorite, . . . .	-	-	-	-	-	11.33	7.89	10.05	9.60

An examination of the above statements concerning the daily average yield of milk of the different cows on trial during the different feeding periods shows, almost without exception, that *our changes in the coarse fodder constituents of the daily diet have affected the results more seriously than our changes in the grain feed portion.* Among the coarse



feed constituents used, ranks first mixed ensilage and rowen (periods IV., V.), then rowen (I., II., III., VIII., IX.) and dry corn stover last (VI., VII.), as far as the daily yield of milk is concerned.

The difference noticeable in the daily average yield of milk in case of rowen, as compared with corn stover, does in no instance deprive the latter of the claim to be the cheaper coarse fodder article of the two in our trial. Mixed ensilage, with rowen in place of corn stover, on the other hand, has raised in some instances the daily yield of milk more than three quarts (Pearl and Buttercup); allowing three cents per quart of milk makes the former the cheaper coarse fodder article of the two, under otherwise corresponding circumstances. These results are noticeable without reference to the particular combination of grain feed rations used in either case.

The influence of the various grain feed rations on the yield of milk in case of the same kind of coarse fodder ration is apparently, to a considerable degree, depending on the individual disposition of the animal on trial. Cotton-seed meal containing grain feed rations give in five out of six cases better results when fed with rowen than either gluten meal or old-process linseed meal ration, under otherwise corresponding conditions. Gluten meal and cotton-seed meal did equally well when fed with either mixed ensilage or corn stover. Old-process linseed meal has only been fed with rowen on the present occasion (I., II., III.); it compared well in yield of milk with gluten meal.

I. — Variations in daily production of milk during the entire feeding experiment (quarts).

II. — Average quantity of milk per day for the entire feeding experiment (quarts).

	I.	II.
Jessie, . . . . .	5.80 — 8.48	6.58
Pearl, . . . . .	7.34 — 12.19	9.86
Pink, . . . . .	6.56 — 8.30	7.51
Roxy, . . . . .	5.23 — 6.81	5.89
Buttercup, . . . . .	8.69 — 13.36	10.80
Nancy, . . . . .	7.49 — 8.54	8.07
Clarissa, . . . . .	9.47 — 11.37	10.29
Juno, . . . . .	6.45 — 7.50	6.99
Favorite, . . . . .	7.89 — 11.33	9.72

*Average Composition of Milk during Different Feeding Periods.*

PERIODS.		1	2	3	4	5	6	7	8	9
		Jessie.	Pearl.	Pink.	Roxy.	Buttercup.	Nancy.	Clarissa.	Juno.	Favorite.
I., . .	{ Solids, per cent., Fat, per cent., .	15.62 6.17	12.62 3.92	15.37 5.70	14.79 5.19	- -	13.13 4.41	- -	13.91 4.71	- -
II., . .	{ Solids, per cent., Fat, per cent., .	17.85 7.39	12.77 4.00	14.73 5.13	15.18 5.12	- -	13.33 4.31	- -	13.82 4.36	- -
III., . .	{ Solids, per cent., Fat, per cent., .	17.69 7.07	13.50 4.06	- -	15.31 5.00	- -	14.47 4.80	- -	14.30 4.88	- -
IV., . .	{ Solids, per cent., Fat, per cent., .	17.61 7.09	- -	15.90 6.00	- -	12.64 3.65	14.68 5.00	- -	14.34 4.96	- -
V., . .	{ Solids, per cent., Fat, per cent., .	17.36 7.02	13.69 4.27	15.53 5.74	- -	12.81 3.79	14.75 5.00	- -	- -	- -
VI., . .	{ Solids, per cent., Fat, per cent., .	17.02 6.47	13.94 4.48	15.86 5.67	- -	12.64 3.96	- -	- -	- -	13.09 4.35
VII., . .	{ Solids, per cent., Fat, per cent., .	17.63 7.26	14.32 5.04	16.56 6.09	- -	12.50 4.06	- -	14.18 5.01	- -	13.53 4.58
VIII., . .	{ Solids, per cent., Fat, per cent., .	- -	13.74 4.84	15.82 5.65	- -	12.98 4.18	- -	14.18 5.08	- -	12.78 4.19
IX., . .	{ Solids, per cent., Fat, per cent., .	- -	13.66 4.04	15.54 5.43	- -	13.45 4.27	- -	13.79 4.60	- -	12.40 3.48

*Live Weight of Animals during the Feeding Periods (Pounds).*

NAME.	FEEDING PERIODS.									Gain at Close.
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	
Jessie, . . .	926	920	965	976	988	951	938	-	-	12
Pearl, . . .	850	877	869	-	872	853	858	853	880	30
Pink, . . .	910	932	-	914	948	947	952	956	973	63
Roxy, . . .	1,010	1,016	992	-	-	-	-	-	-	-18
Buttercup, . . .	-	-	-	781	797	795	785	766	775	-6
Nancy, . . .	946	942	948	963	987	-	-	-	-	41
Clarissa, . . .	-	-	-	-	-	-	833	856	848	16
Juno, . . .	1,142	1,124	1,135	1,114	-	-	-	-	-	-23
Favorite, . . .	-	-	-	-	-	826	775	809	801	-26

*Conclusions.* — A careful examination of the previously recorded results of our inquiry into the respective particular claims of cotton-seed meal, old-process linseed meal and gluten meal as constituents of the daily diet of milch cows, leads us to the following statements: —

1. The substitution of three pounds of gluten meal by either three pounds of cotton-seed meal or three pounds of old-process linseed meal, at stated market prices, and under otherwise corresponding circumstances, does not materially effect the *market cost* of the daily fodder ration used in our case. The difference in their market price amounts to 0.3 cents in favor of old-process linseed meal. Taking the obtainable manurial value into consideration, as far as the three stated grain feed constituents of the daily diet are concerned, three pounds of cotton-seed meal are 0.94 cents cheaper than three pounds of gluten meal and 0.22 cents cheaper than three pounds of old-process linseed meal.

2. The comparative nutritive effect of cotton-seed meal, gluten meal and old-process linseed meal, as far as their influence on the yield of milk is concerned, in case of otherwise corresponding fodder rations, depends evidently in a controlling degree on two distinctly different circumstances, namely, the individual disposition and constitution of the animal on trial, and on the particular kind of coarse fodder constituent of the daily diet. In case of rowen as coarse fodder constituent, cotton-seed meal leads, in five out of six cases, both gluten meal and old-process linseed meal, while in case mixed ensilage or corn stover served as coarse feed the gluten meal competes well with cotton-seed meal. Old-process linseed meal has only been tested with rowen on the present occasion; it stands but little behind the gluten meal.

3. The density of the milk in case of the same cow varies but little during the experiment; the notable changes are apparently, in a controlling degree, due to the particular condition and individuality of the cow engaged in the trial.

## FEEDING RECORD.

## I. Jessie.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.							Amount of Dry Vegetable Matter contained in the Daily Ration consumed (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Cotton-seed Meal.	Old-process Lardless Meal.	Gluten Meal.	Howen.	Corn and Beans Meal.	Corn Stover.				
1890-91.												
Nov. 1 to Nov. 21, . . .	3.00	3.00	3.00	-	-	17.81	-	-	6.77	3.44	1:4.51	926
Nov. 26 to Dec. 16, . . .	3.00	3.00	-	-	3.00	16.23	-	-	5.30	4.13	1:5.09	920
Dec. 22 to Jan. 11, . . .	3.00	3.00	-	3.00	-	17.91	-	-	5.70	4.11	1:4.85	965
Jan. 26 to Feb. 11, . . .	3.00	3.00	3.00	-	-	5.00	43.94	-	7.54	3.31	1:4.19	976
Feb. 14 to March 4, . . .	3.00	3.00	-	-	3.00	5.00	47.11	-	8.48	3.05	1:4.71	988
March 10 to March 25, . . .	3.00	3.00	-	-	3.00	-	-	11.16	6.80	2.48	1:6.83	951
March 28 to April 12, . . .	3.00	3.00	3.00	-	-	-	-	13.59	5.50	3.43	1:5.61	938

## 2. Pearl.

Nov. 1 to Nov. 21, . . .	3.00	3.00	3.00	-	-	21.19	-	-	10.74	2.44	1:4.65	850
Nov. 26 to Dec. 16, . . .	3.00	3.00	-	-	3.00	17.81	-	-	10.28	2.26	1:5.14	877
Dec. 22 to Jan. 11, . . .	3.00	3.00	-	3.00	-	18.26	-	-	10.84	2.19	1:4.86	869
Feb. 14 to March 4, . . .	3.00	3.00	-	-	3.00	5.00	48.05	-	12.19	2.14	1:4.71	872
March 10 to March 25, . . .	3.00	3.00	-	-	3.00	-	-	16.06	9.07	2.29	1:7.06	853
March 28 to April 12, . . .	3.00	3.00	3.00	-	-	-	-	14.50	7.34	2.67	1:5.74	858
April 16 to May 6, . . .	3.00	3.00	3.00	-	-	19.40	-	-	9.19	2.68	1:4.57	853
May 11 to May 31, . . .	3.00	3.00	-	-	3.00	18.33	-	-	9.24	2.56	1:5.16	890

## FEEDING RECORD — Continued.

## 3. Pink.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.								Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Cotton-seed Meal.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn and Soyabean Meal.	Corn Steep.				
1900-01.												
Nov. 1 to Nov. 21, .	3.00	3.00	3.00	-	-	21.83	-	-	7.55	3.54	1:4.67	910
Nov. 26 to Dec. 16, .	3.00	3.00	-	-	3.00	20.81	-	-	7.42	3.49	1:5.23	932
Jan. 26 to Feb. 11, .	3.00	3.00	3.00	-	-	5.00	46.59	-	8.07	3.19	1:4.20	914
Feb. 14 to March 4, .	3.00	3.00	-	-	3.00	5.00	48.79	-	8.80	3.17	1:4.71	948
March 10 to March 25, .	3.00	3.00	-	-	3.00	-	-	15.75	7.06	2.91	1:7.01	947
March 28 to April 12, .	3.00	3.00	3.00	-	-	-	-	17.50	6.56	3.35	1:6.15	952
April 16 to May 6, .	3.00	3.00	3.00	-	-	19.57	-	-	7.48	3.32	1:4.68	946
May 11 to May 31, .	3.00	3.00	-	-	3.00	19.38	-	-	7.63	3.22	1:5.19	973

## 4. Rozy.

Nov. 1 to Nov. 21, .	3.00	3.00	3.00	-	-	19.14	-	-	6.81	3.59	1:4.56	1,010
Nov. 26 to Dec. 16, .	3.00	3.00	-	-	3.00	15.74	-	-	5.64	3.80	1:5.07	1,016
Dec. 22 to Jan. 11, .	3.00	3.00	-	3.00	-	15.24	-	-	5.23	4.04	1:4.74	992

5. *Buttercup.*

Jan. 29 to Feb. 11,	.	3.00	3.00	3.00	3.00	—	—	5.00	42.61	—	24.60	13.86	1.84	1:4.18	781
Feb. 14 to March 4,	.	3.00	3.00	3.00	3.00	—	—	5.00	44.26	—	25.04	13.31	1.88	1:4.70	797
March 10 to March 25,	.	3.00	3.00	3.00	3.00	—	—	—	—	15.41	20.25	10.66	1.90	1:6.96	795
March 28 to April 12,	.	3.00	3.00	3.00	3.00	—	—	—	—	16.34	21.04	9.31	2.26	1:6.00	785
April 16 to May 6,	.	3.00	3.00	3.00	3.00	—	—	15.98	—	—	21.71	9.45	2.30	1:4.42	766
May 11 to May 31,	.	3.00	3.00	3.00	3.00	—	—	15.57	—	—	31.32	8.69	2.45	1:5.07	775

6. *Nancy.*

Nov. 1 to Nov. 21,	.	3.00	3.00	3.00	3.00	3.00	—	20.83	—	—	25.88	8.34	3.10	1:4.63	946
Nov. 26 to Dec. 16,	.	3.00	3.00	3.00	3.00	—	—	18.45	—	—	23.80	7.68	3.10	1:5.16	942
Dec. 22 to Jan. 11,	.	3.00	3.00	3.00	3.00	3.00	—	18.19	—	—	23.64	7.49	3.16	1:4.86	948
Jan. 26 to Feb. 11,	.	3.00	3.00	3.00	3.00	—	—	5.00	41.41	—	24.26	8.31	2.92	1:4.17	963
Feb. 14 to March 4,	.	3.00	3.00	3.00	3.00	—	—	5.00	42.63	—	24.57	8.54	2.88	1:4.69	987

7. *Clarissa.*

March 28 to April 12,	.	3.00	3.00	3.00	3.00	—	—	—	—	14.31	19.41	9.47	2.05	1:5.72	833
April 16 to May 6,	.	3.00	3.00	3.00	3.00	—	—	18.48	—	—	23.86	10.04	2.38	1:4.54	836
May 11 to May 31,	.	3.00	3.00	3.00	3.00	—	—	19.43	—	—	24.64	11.37	2.17	1:5.19	843

## FEEDING RECORD — Concluded.

8. *Junco*.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.								Amount of Dry Vegetable Matter contained in the Daily Ration (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during Period (Pounds).
	Corn Meal.	Wheat Bran.	Cotton-seed Meal.	Old-process Linseed Meal.	Gluten Meal.	Barley.	Corn and Soybean Meal.	Corn Shovel.					
1899-91.													
Nov. 1 to Nov. 21, .	8.00	8.00	3.00	-	-	19.50	-	-	24.74	7.29	8.89	1:4.58	1,142
Nov. 26 to Dec. 16, .	8.00	8.00	-	-	3.00	16.02	-	-	21.70	6.70	8.24	1:5.08	1,124
Dec. 22 to Jan. 11, .	8.00	8.00	-	8.00	-	17.29	-	-	22.87	6.45	8.55	1:4.82	1,185
Jan. 26 to Feb. 11, .	8.00	8.00	3.00	-	-	5.00	36.28	-	22.76	7.50	8.03	1:4.13	1,114

9. *Favorita*.

March 10 to March 25, .	8.00	8.00	-	-	3.00	-	-	11.16	16.85	11.33	1.49	1:6.33	826
March 28 to April 12, .	8.00	8.00	3.00	-	-	-	-	8.22	14.54	7.89	1.84	1:4.76	775
April 16 to May 6, .	8.00	8.00	3.00	-	-	14.48	-	-	20.42	10.05	2.03	1:4.34	809
May 11 to May 31, .	8.00	8.00	-	-	3.00	14.19	-	-	20.13	9.60	2.10	1:5.01	801

## TOTAL COST OF FEED PER QUART OF MILK.

1. *Jessie.*

FEEDING PERIODS.		Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rye or Corn consumed (Pounds).	Total Amount of Corn and Soya Bean Meal consumed (Pounds).	Total Amount of Corn Stover consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
<b>1890-91.</b>													
Nov. 1 to Nov. 21,	.	142.21	6.77	63.00	63.00	63.00	-	-	374.00	-	-	\$5.96	3.77
Nov. 26 to Dec. 16,	.	111.40	5.90	63.00	63.00	-	-	63.00	343.00	-	-	5.12	4.60
Dec. 22 to Jan. 11,	.	119.77	5.70	63.00	63.00	-	63.00	-	376.00	-	-	5.81	4.43
Jan. 26 to Feb. 11,	.	128.26	7.54	51.00	51.00	51.00	-	-	85.00	747.00	-	4.01	3.13
Feb. 14 to March 4,	.	161.02	8.48	57.00	57.00	-	-	57.00	95.00	895.00	-	4.69	2.91
March 10 to March 25,	.	108.72	6.80	48.00	48.00	-	-	48.00	-	-	178.50	2.39	2.20
March 28 to April 12,	.	88.02	5.50	48.00	48.00	48.00	-	-	-	-	217.50	2.48	2.32

2. *Pearl.*

Nov. 1 to Nov. 21,	.	225.58	10.74	63.00	63.00	63.00	-	-	445.00	-	-	\$5.89	2.61
Nov. 26 to Dec. 16,	.	215.81	10.28	63.00	63.00	-	-	63.00	374.00	-	-	5.36	2.48
Dec. 22 to Jan. 11,	.	227.56	10.84	63.00	63.00	-	63.00	-	383.50	-	-	5.37	2.37
Feb. 14 to March 4,	.	231.74	12.19	57.00	57.00	-	-	57.00	95.00	913.00	-	4.62	1.99
March 10 to March 25,	.	145.12	9.07	48.00	48.00	-	-	48.00	-	-	257.00	2.58	1.78
March 28 to April 12,	.	117.44	7.34	48.00	48.00	48.00	-	-	-	-	232.00	2.52	2.15
April 16 to May 6,	.	193.05	9.19	63.00	63.00	63.00	-	-	407.50	-	-	5.61	2.91
May 11 to May 31,	.	194.07	9.24	63.00	63.00	-	-	63.00	385.00	-	-	5.44	2.80



## TOTAL COST OF FEED PER QUART OF MILK — Continued.

3. *Pink.*

FEEDING PERIODS.		Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Barley consumed (Pounds).	Total Amount of Corn and Soybean Meal consumed (Pounds).	Total Amount of Stover consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1890-91.													
Nov. 1 to Nov. 21,	.	158.49	7.55	63.00	63.00	63.00	—	—	458.50	—	—	\$5.99	3.78
Nov. 26 to Dec. 16,	.	155.81	7.42	63.00	63.00	—	—	63.00	437.00	—	—	5.83	3.74
Jan. 26 to Feb. 11,	.	137.21	8.07	51.00	51.00	51.00	—	—	85.00	792.00	—	4.09	2.98
Feb. 14 to March 4,	.	155.79	8.30	57.00	57.00	—	—	—	95.00	990.00	—	4.75	3.05
March 10 to March 25,	.	112.79	7.05	48.00	48.00	—	—	48.00	—	—	252.00	2.57	2.28
March 28 to April 12,	.	105.00	6.56	48.00	48.00	48.00	—	—	—	—	280.00	2.64	2.51
April 16 to May 6,	.	157.09	7.48	63.00	63.00	63.00	—	—	411.00	—	—	5.63	3.58
May 11 to May 31,	.	160.23	7.63	63.00	63.00	—	—	63.00	407.00	—	—	5.60	3.49

4. *Rosy.*

Nov. 1 to Nov. 21,	.	148.02	6.81	63.00	63.00	63.00	—	—	402.00	—	—	\$5.57	3.89
Nov. 26 to Dec. 16,	.	118.49	5.64	63.00	63.00	—	—	63.00	330.50	—	—	5.03	4.25
Dec. 22 to Jan. 11,	.	103.77	5.23	63.00	63.00	—	63.00	—	320.00	—	—	4.89	4.45

5. *Buttercup.*

Jan. 29 to Feb. 11,	186.98	13.36	42.00	42.00	42.00	-	-	70.00	596.50	-	\$3 27	1.75
Feb. 14 to March 4,	252.80	13.31	57.00	57.00	-	-	-	95.00	841.00	-	4 49	1.78
March 10 to March 25,	170.68	10.66	48.00	48.00	-	-	-	-	-	246.50	2 56	1.60
March 28 to April 12,	148.95	9.31	48.00	48.00	48.00	-	-	-	-	261.50	2 59	1.74
April 16 to May 6,	198.49	9.45	63.00	63.00	63.00	-	-	335.50	-	-	5 07	2.55
May 11 to May 31,	182.56	8.69	63.00	63.00	-	-	-	327.00	-	-	5 00	2.74

6. *Nancy.*

Nov. 1 to Nov. 21,	175.23	8.34	63.00	63.00	63.00	-	-	497.50	-	-	\$5 88	3.38
Nov. 26 to Dec. 16,	161.28	7.68	63.00	63.00	-	-	-	387.50	-	-	5 46	3.39
Dec. 22 to Jan. 11,	157.21	7.49	63.00	63.00	-	63.00	-	382.00	-	-	5 35	3.40
Jan. 26 to Feb. 11,	141.28	8.31	51.00	51.00	51.00	-	-	86.00	704.00	-	3 93	2.78
Feb. 14 to March 4,	162.33	8.54	57.00	57.00	-	-	-	95.00	810.00	-	4 44	2.73

7. *Clarissa.*

March 28 to April 12,	151.51	9.47	48.00	48.00	48.00	-	-	-	-	229.00	\$2 51	1.66
April 16 to May 6,	210.81	10.04	63.00	63.00	63.00	-	-	388.00	-	-	5 46	2.59
May 11 to May 31,	238.72	11.37	63.00	63.00	-	-	-	408.00	-	-	5 61	2.35

TOTAL COST OF FEED PER QUART OF MILK — *Concluded.*8. *June.*

FEEDING PERIODS.		Total quantity of Milk produced (quarts).	Average Daily Yield of Milk (quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Old-process Linseed Meal consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Corn and Soya Bean Meal consumed (Pounds).	Total Amount of Corn (Pounds).	Total Amount of Clover consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1890-91.														
Nov. 1 to Nov. 21,	.	153.14	7.29	63.00	63.00	63.00	-	-	409.50	-	-	-	\$5 62	3.67
Nov. 26 to Dec. 16,	.	140.70	6.70	63.00	63.00	-	-	63.00	338.50	-	-	-	5 07	3.60
Dec. 23 to Jan. 11,	.	135.35	6.45	63.00	63.00	-	63.00	-	363.00	-	-	-	5 21	3.85
Jan. 26 to Feb. 11,	.	127.56	7.50	51.00	51.00	51.00	-	-	85.00	616.00	-	-	3 78	2.96

9. *Favorite.*

March 10 to March 25,	.	181.28	11.33	48.00	48.00	-	-	48.00	-	-	178.50	-	\$2 39	1.32
March 28 to April 12,	.	126.30	7.89	48.00	48.00	48.00	-	-	-	-	131.50	-	2 27	1.80
April 16 to May 6,	.	211.05	10.06	63.00	63.00	63.00	-	-	304.00	-	-	-	4 83	2.29
May 11 to May 31,	.	201.51	9.60	63.00	63.00	-	-	63.00	298.00	-	-	-	4 79	2.38

## NET COST OF MILK AND MANURIAL VALUE OF FEED CONSUMED.

1. *Jessie.*

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
1890-91.					Cents.	Pounds.
Nov. 1 to Nov. 21, .	\$5 36	\$2 81	\$2 25	\$3 11	2.19	920
Nov. 26 to Dec. 16, .	5 12	2 42	1 94	3 18	2.85	947
Dec. 22 to Jan. 11, .	5 31	2 67	2 14	3 17	2.65	998
Jan. 26 to Feb. 11, .	4 01	2 53	2 02	1 99	1.55	973
Feb. 14 to Mar. 4, .	4 69	2 68	2 14	2 55	1.58	995
Mar. 10 to Mar. 25, .	2 39	1 15	0 92	1 47	1.35	940
Mar. 28 to Apr. 12, .	2 48	1 41	1 13	1 35	1.53	932
Total, . . .	\$29 36	\$15 67	\$12 54	\$16 82	—	—

2. *Pearl.*

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
Nov. 1 to Nov. 21, .	\$5 89	\$3 08	\$2 46	\$3 43	1.52	864
Nov. 26 to Dec. 16, .	5 36	2 55	2 04	3 32	1.54	876
Dec. 22 to Jan. 11, .	5 37	2 70	2 16	3 21	1.41	876
Feb. 14 to Mar. 4, .	4 62	2 71	2 17	2 45	1.06	873
Mar. 10 to Mar. 25, .	2 58	1 29	1 03	1 55	1.07	850
Mar. 28 to Apr. 12, .	2 52	1 44	1 15	1 37	1.17	865
Apr. 16 to May 6, .	5 61	2 94	2 35	3 26	1.69	842
May 11 to May 31, .	5 44	2 59	2 07	3 37	1.74	874
Total, . . .	\$37 39	\$19 30	\$15 43	\$21 96	—	—

3. *Pink.*

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
Nov. 1 to Nov. 21, .	\$5 99	\$3 14	\$2 51	\$3 48	2.20	910
Nov. 26 to Dec. 16, .	5 83	2 80	2 24	3 59	2.30	950
Jan. 26 to Feb. 11, .	4 09	2 60	2 08	2 01	1.47	922
Feb. 14 to Mar. 4, .	4 75	2 83	2 26	2 49	1.60	953
Mar. 10 to Mar. 25, .	2 57	1 28	1 02	1 55	1.37	940
Mar. 28 to Apr. 12, .	2 64	1 52	1 22	1 42	1.35	970
Apr. 16 to May 6, .	5 63	2 95	2 36	3 27	2.08	940
May 11 to May 31, .	5 60	2 68	2 14	3 46	2.16	973
Total, . . .	\$37 10	\$19 80	\$15 83	\$21 27	—	—

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## NET COST OF MILK AND MANURIAL VALUE OF FEED — *Continued.*

### 4. Roxy.

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
<b>1890-91.</b>					Cents.	Pounds.
Nov. 1 to Nov. 21, .	\$5 57	\$2 92	\$2 34	\$3 23	2.26	1,008
Nov. 26 to Dec. 16, .	5 03	2 38	1 90	3 13	2.64	1,034
Dec. 22 to Jan. 11, .	4 89	2 45	1 96	2 93	2.67	1,010
<b>Total, . .</b>	<b>\$15 49</b>	<b>\$7 75</b>	<b>\$6 20</b>	<b>\$9 29</b>	<b>-</b>	<b>-</b>

### 5. Buttercup.

Jan. 29 to Feb. 11, .	\$3 27	\$2 05	\$1 64	\$1 63	0.87	800
Feb. 14 to Mar. 4, .	4 49	2 60	2 08	2 41	1.29	797
Mar. 10 to Mar. 25, .	2 56	1 27	1 01	1 55	0.91	800
Mar. 28 to Apr. 12, .	2 59	1 49	1 19	1 40	0.94	795
Apr. 16 to May 6, .	5 07	2 66	2 13	2 94	1.48	753
May 11 to May 31, .	5 00	2 36	1 89	3 11	1.70	775
<b>Total, . .</b>	<b>\$22 98</b>	<b>\$12 43</b>	<b>\$9 94</b>	<b>\$13 04</b>	<b>-</b>	<b>-</b>

### 6. Nancy.

Nov. 1 to Nov. 21, .	\$5 83	\$3 06	\$2 45	\$3 38	1.93	925
Nov. 26 to Dec. 16, .	5 46	2 60	2 08	3 38	2.10	960
Dec. 22 to Jan. 11, .	5 35	2 70	2 16	3 19	2.03	973
Jan. 26 to Feb. 11, .	3 93	2 47	1 97	1 96	1.39	963
Feb. 14 to Mar. 4, .	4 44	2 56	2 05	2 39	1.47	985
<b>Total, . .</b>	<b>\$25 01</b>	<b>\$13 39</b>	<b>\$10 71</b>	<b>\$14 30</b>	<b>-</b>	<b>-</b>

### 7. Clarissa.

Mar. 28 to Apr. 12, .	\$2 51	\$1 43	\$1 14	\$1 37	0.90	843
Apr. 16 to May 6, .	5 46	2 86	2 29	3 17	1.50	835
May 11 to May 31, .	5 61	2 68	2 14	3 47	1.45	855
<b>Total, . .</b>	<b>\$13 58</b>	<b>\$6 97</b>	<b>\$5 57</b>	<b>\$8 01</b>	<b>-</b>	<b>-</b>

NET COST OF MILK AND MANURIAL VALUE OF FEED—*Concluded.*8. *June.*

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
<b>1890-91.</b>					Cents.	Pounds.
Nov. 1 to Nov. 21, .	\$5 62	\$2 95	\$2 36	\$3 26	2.13	1,130
Nov. 26 to Dec. 16, .	5 07	2 40	1 92	3 15	2.24	1,143
Dec. 22 to Jan. 11, .	5 21	2 62	2 10	3 11	2.30	1,150
Jan. 26 to Feb. 11, .	3 78	2 34	1 87	1 91	1.50	1,105
Total, . . .	\$19 68	\$10 31	\$8 25	\$11 43	—	—

9. *Favorite.*

Mar. 10 to Mar. 25, .	\$2 39	\$1 15	\$0 92	\$1 47	0.81	790
Mar. 28 to Apr. 12, .	2 27	1 26	1 01	1 26	0.99	785
Apr. 16 to May 6, .	4 83	2 53	2 02	2 81	1.33	782
May 11 to May 31, .	4 79	2 25	1 80	2 99	1.48	797
Total, . . .	\$14 28	\$7 19	\$5 75	\$8 53	—	—

*Composition of Fodder Articles fed during the Above-described Feeding Experiment.**Corn Meal (Average).*

1890-91.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	13.26	265.20	—	—	1:8.62
Dry matter, . . . . .	86.74	1,734.80	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.72	34.40	—	—	
“ cellulose, . . . . .	2.28	45.60	21.89	48	
“ fat, . . . . .	4.90	98.00	83.30	85	
“ protein (nitrogenous matter), . . . . .	12.94	258.80	204.45	79	
Non-nitrogenous extract matter, . . . . .	78.16	1,563.20	1,531.94	98	
	100.00	2,000.00	1,841.58	—	

*Composition of Fodder Articles, etc. — Continued.**Wheat Bran (Average).*

1890-91.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	12.11	242.20	-	-	} 1 : 3.86
Dry matter, . . . . .	87.89	1,757.80	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	7.40	148.00	-	-	
“ cellulose, . . . . .	12.17	243.40	58.42	24	
“ fat, . . . . .	5.04	100.80	71.57	71	
“ protein (nitrogenous matter), . . . . .	18.48	369.60	288.29	78	
Non-nitrogenous extract matter, . . . . .	56.91	1,138.20	876.41	77	
	100.00	2,000.00	1,294.69	-	

*Cotton-seed Meal (Average).*

1890-91.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	9.77	195.40	-	-	} 1 : 1.37
Dry matter, . . . . .	90.23	1,804.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	8.18	163.60	-	-	
“ cellulose, . . . . .	7.74	154.80	-	-	
“ fat, . . . . .	11.33	226.60	199.41	88	
“ protein (nitrogenous matter), . . . . .	44.41	888.20	754.97	85	
Non-nitrogenous extract matter, . . . . .	28.34	566.80	538.46	95	
	100.00	2,000.00	1,492.84	-	

*Composition of Fodder Articles, etc. — Continued.**Old-process Linseed Meal.*

1890-91.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	8.72	174.40	-	-	1:1.93
Dry matter, . . . . .	91.28	1,825.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	5.96	119.20	-	-	
“ cellulose, . . . . .	8.23	164.60	42.79	26	
“ fat, . . . . .	9.87	197.40	179.63	91	
“ protein (nitrogenous matter), . . . . .	36.19	723.80	629.70	87	
Non-nitrogenous extract matter, . . . . .	39.75	795.00	723.45	91	
	100.00	2,000.00	1,575.57	-	

*Gluten Meal.*

1890-91.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	10.90	218.00	-	-	1:2.44
Dry matter, . . . . .	89.10	1,782.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.02	20.40	-	-	
“ cellulose, . . . . .	1.28	25.60	15.87	62	
“ fat, . . . . .	7.36	147.20	125.12	85	
“ protein (nitrogenous matter), . . . . .	34.79	695.80	549.68	79	
Non-nitrogenous extract matter, . . . . .	55.55	1,111.00	1,011.01	91	
	100.00	2,000.00	1,701.68	-	



*Composition of Fodder Articles, etc. — Continued.**Rowen (Average).*

1899-91.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds	Pounds Digestible in a Ton of 2,000 Pounds	Per Cent. of Digestibility of Constituents	Nutritive Ratio.
Moisture at 100° C., . . .	13.90	278.00	-	-	1:6.85
Dry matter, . . . . .	86.10	1,722.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	8.28	165.60	-	-	
“ cellulose, . . . . .	28.88	577.60	369.66	64	
“ fat, . . . . .	3.91	78.20	35.97	46	
“ protein (nitrogenous matter), . . . . .	13.45	269.00	166.78	62	
Non-nitrogenous extract matter, . . . . .	45.48	909.60	600.34	66	
	100.00	2,000.00	1,172.75	-	

*Corn and Soja Bean Ensilage.*

1899-91.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	71.03	1,420.60	-	-	1:1.94
Dry matter, . . . . .	28.97	579.40	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	11.04	220.80	-	-	
“ cellulose, . . . . .	27.84	556.80	339.65	61	
“ fat, . . . . .	5.35	107.00	69.55	65	
“ protein (nitrogenous matter), . . . . .	15.27	305.40	216.83	71	
Non-nitrogenous extract matter, . . . . .	40.50	810.00	558.90	69	
	100.00	2,000.00	1,184.93	-	

*Composition of Fodder Articles, etc. — Concluded.**Corn Stover.*

1890-91.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	19.89	397.80	—	—	1:14.84
Dry matter, . . . . .	80.11	1,602.20	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.33	126.60	—	—	
“ cellulose, . . . . .	34.59	691.80	498.10	72	
“ fat, . . . . .	1.28	25.60	19.20	75	
“ protein (nitrogenous matter), . . . . .	5.74	114.80	83.80	73	
Non-nitrogenous extract matter, . . . . .	52.06	1,041.20	697.60	67	
	100.00	2,000.00	1,298.70	—	

3. *Summer Feeding Experiment with Milch Cows,  
July 6 to Sept. 26, 1891.*

Green feed: vetch and oats, soja beans and fodder corn.

Grain feed: corn meal, wheat bran, dried brewers' grain, gluten meal (Chicago).

The feeding experiment here under discussion is a continuation of similar ones carried on during the summer season in preceding years (since 1887) for the purpose of ascertaining the comparative feeding value and the general economy of various reputed green fodder crops in the dairy industry. Our late observation includes, of green crops, besides vetch and oats and soja beans of former years, as an addition the green fodder corn. The two first named green crops were cut for feed at the beginning of blooming, and they were fed until our supply was either exhausted or until they were fully matured yet still succulent. The green fodder corn was first cut for feed when the kernels were fully developed yet in the milk. The grain feed ration consisted throughout the entire experiment of corn meal and gluten meal, alternating either with wheat bran or dried brewers' grain. The daily ration of grain feed amounted

throughout the entire experiment to nine pounds per head; three pounds of corn meal and three pounds of Chicago gluten meal *with either three pounds of wheat bran or with three pounds of dried brewers' grain, for the purpose of comparing the economical merits of these two articles in connection with the production of milk.*

The daily rations of coarse feed consisted of five pounds of rowen — hay of second cut of upland meadows — and of either a mixed green crop of vetch and oats, or of green soja bean or of green fodder corn. The daily consumption per head of grain feed and of hay, as far as quantity is concerned, remained the same in case of every animal during the entire experiment, while that of the green fodder crops was governed by the appetite of each animal on trial. The quantity daily consumed decreased as a rule with their advancing growth, on account of the steady increase of solid matter in the plants. The daily consumption of vetch and oats varied at different feeding periods from 45 to 35 pounds in case of the same animals, and that of soja beans from 44 to 38 pounds, while that of green fodder corn varied from 50 to 38 pounds in case of different animals (fifth feeding period).

A record of the composition and general character of the various fodder constituents of the daily diet will be found farther on.

Five cows, grades of various descriptions and in different milking periods, served in the trial.

The subsequent statement shows the average composition of the daily fodder rations used in the trial during five succeeding feeding periods into which the entire experiment was divided.

*Statement of the Average Daily Fodder Rations used during  
the Different Feeding Periods.*

I	
Corn meal, . . . . .	3.00 lbs.
Brewers' grain, . . . . .	3.00 "
Gluten meal, . . . . .	3.00 "
Rowen, . . . . .	5.00 "
Vetch and oats (green), . . . . .	47.24 "
Total cost, . . . . .	22.39 cts
Net cost, . . . . .	12.96 "
Manurial value obtainable, . . . . .	9.48 "
Nutritive ratio, . . . . .	1:6.17

*Average Daily Fodder Rations, etc. — Concluded.*

## II.

Corn meal, . . . . .	3.00 lbs.
Wheat bran, . . . . .	3.00 "
Gluten meal, . . . . .	3.00 "
Rowen, . . . . .	5.00 "
Vetch and oats (green), . . . . .	36.42 "
Total cost, . . . . .	20.91 cts.
Net cost, . . . . .	12.52 "
Manurial value obtainable, . . . . .	8.39 "
Nutritive ratio, . . . . .	1:6.29

## III.

Corn meal, . . . . .	3.00 lbs.
Wheat bran, . . . . .	3.00 "
Gluten meal, . . . . .	3.00 "
Rowen, . . . . .	5.00 "
Soja beans (green), . . . . .	51.28 "
Total cost, . . . . .	27.18 cts.
Net cost, . . . . .	17.32 "
Manurial value obtainable, . . . . .	9.86 "
Nutritive ratio, . . . . .	1:5.07

## IV.

Corn meal, . . . . .	3.00 lbs.
Brewers' grain, . . . . .	3.00 "
Gluten meal, . . . . .	3.00 "
Rowen, . . . . .	5.00 "
Soja beans, . . . . .	47.34 "
Total cost, . . . . .	26.31 cts.
Net cost, . . . . .	16.65 "
Manurial value obtainable, . . . . .	9.66 "
Nutritive ratio, . . . . .	1:4.76

## V.

Corn meal, . . . . .	3.00 lbs.
Brewers' grain, . . . . .	3.00 "
Gluten meal, . . . . .	3.00 "
Rowen, . . . . .	5.00 "
Fodder corn (green), . . . . .	39.22 "
Total cost, . . . . .	20.80 cts.
Net cost, . . . . .	12.67 "
Manurial value obtainable, . . . . .	8.13 "
Nutritive ratio, . . . . .	1:6.17

*Local Market Cost of the Various Articles of Fodder  
used (per Ton).*

Corn meal, . . . . .	\$31 00
Brewers' grain, . . . . .	23 00
Wheat bran, . . . . .	23 00
Gluten meal, . . . . .	27 00
Rowen, . . . . .	15 00
Vetch and oats (green), . . . . .	2 75
Fodder corn (green), . . . . .	2 50
Soja beans (green), . . . . .	4 40

*Essential Fertilizing Constituents of the Above Fodder Articles.*

Nitrogen, 15 cents; phosphoric acid, 5½ cents; potassium oxide, 4½ cents per pound.

	Corn Meal.	Brewers' Grain.	Wheat Bran.	Gluten Meal.	Rowen	Vetch and Oats.	Fodder Corn.	Soja Beans.
Moisture, . . .	15.31	12.00	12.99	11.11	13.90	67.49	71.86	74.23
Nitrogen, . . .	1.661	3.290	2.249	4.741	1.853	.459	.343	.566
Phosphoric acid, . . .	.603	1.192	2.793	.413	.464	.202	.195	.183
Potassium oxide, . . .	.426	1.466	1.592	.044	1.906	.487	.430	.297
Valuation per 2,000 pounds, . .	\$6 10	\$12 52	\$11 25	\$14 72	\$7 84	\$2 04	\$1 63	\$2 10

*History of Cows (Grades).*

NAME.	Breed.	Age (Year).	Last Calf dropped.	Daily Yield of Milk at beginning of Trial (Quarts).	No. of Months on Trial.
Cora, . . .	Grade Jersey, .	7	April 16, 1891,	11-12	3
Pearl, . . .	Native, . . .	6	Aug. 8, 1890,	8-9	3
Buttercup, . . .	Grade Ayrshire, .	5	Jan. 2, 1891,	8-9	3
Lucy, . . .	Grade Ayrshire, .	5	June 2, 1891,	12-13	3
Clarissa, . . .	Grade Durham, .	7	March 14, 1891,	9-10	3

*Yield of Milk during Different Feeding Periods (Quarts).*

	Cora.	Pearl.	Buttercup.	Lucy.	Clarissa.
Period I., . . .	11.29	8.11	8.34	12.26	9.49
Period II., . . .	11.34	8.70	8.73	12.78	9.31
Period III., . . .	11.24	8.63	8.76	12.85	10.37
Period IV., . . .	11.57	8.95	8.85	13.26	10.99
Period V., . . .	10.70	8.92	8.64	12.01	9.98
Average, . . .	11.23	8.66	8.66	12.63	10.03

*Conclusions.* — The results of the past season obtained in this connection are very encouraging, as will be seen from the subsequent brief abstract when compared with those noticed in preceding years.

1. The yield of milk is well maintained during the entire experiment of three months. The average daily yield of milk of the various cows for the entire experiment is in four, out of five cases *larger* than their yield at the beginning of the observation; in the fifth case there is practically no change (Cora). The largest average yield of milk was noticed, without any exception as to a particular cow, in case of soja bean as green fodder and dried brewers' grain as ingredient of the daily grain feed ration (fourth feeding period). Green fodder corn leads in three out of five cases the green vetch and oats when fed with dried brewers' grain.

2. The amount of dry vegetable matter consumed per quart of milk produced varies in case of different cows from 1.77 pounds (Cora) to 3.33 pounds (Pearl). The amount consumed in case of the same cows varies in different feeding periods from 1.77 to 2.25 pounds (Cora) and from 2.44 to 3.17 pounds (Buttercup).

3. The total cost of feed consumed per quart of milk produced differs in case of different animals for the same feeding period from 1.69 to 2.30 cents (Lucy and Pearl, fifth feeding period); as far as different feeding periods are concerned it varies in one case from 1.69 to 2.30 cents (Lucy) and in another case from 2.24 to 2.91 cents (Clarissa).

4. The net cost of feed per quart of milk produced varies from 1.01 to 1.43 cents for the same feeding period in case of different animals (Lucy and Pearl, second feeding period).

5. The obtainable manurial value amounts on an average to three-sevenths of the market cost of the feed consumed. The green vetch and oats leads in this connection.

6. The quality of the milk is in every instance improved in the percentage of solids during the experiment without showing any perceptible decrease in yield. Individuality of the animal and stage of lactation affect the results to a controlling extent.

7. Brewers' grain has served as an excellent substitute for wheat bran in our diet for milch cows.

## FEEDING RECORD.

CORA: Age, seven years; grade Jersey; last calf, April 16, 1891.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.							Amount of Dry Veg- etable Matter con- tained in the Daily Ration (pounds).	Quarts of Milk pro- duced per Day.	Pounds of Dry Mat- ter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal during each Feeding Period.
	Corn Meal.	Brewers' Grain.	Wheat Bran.	Gluten Meal.	Rowen.	Vetch and Oats.	Soya Beans.	Podder Corn.				
1891.												Pounds.
July 6 to July 21, .	3.00	3.00	-	3.00	5.00	40.75	-	-	11.29	2.25	1: 6.00	1,053
July 24 to Aug. 2, .	3.00	-	3.00	3.00	5.00	24.90	-	-	11.84	1.77	1: 5.91	1,039
Aug. 6 to Aug. 17, .	3.00	-	3.00	3.00	5.00	-	44.67	-	11.24	2.10	1: 5.05	1,025
Aug. 21 to Sept. 3, .	3.00	3.00	-	3.00	5.00	-	42.86	-	11.57	2.01	1: 4.74	1,013
Sept. 7 to Sept. 26, .	3.00	3.00	-	3.00	5.00	-	-	87.45	10.71	2.12	1: 6.13	1,030

PEARL: Age, six years; native; last calf, Aug. 8, 1890.

July 6 to July 18, .	3.00	3.00	-	3.00	5.00	45.62	-	-	8.11	3.33	1: 6.12	928
July 24 to Aug. 2, .	3.00	-	3.00	3.00	5.00	35.90	-	-	8.70	2.73	1: 6.29	928
Aug. 6 to Aug. 17, .	3.00	-	3.00	3.00	5.00	-	43.08	-	8.61	2.69	1: 5.05	907
Aug. 25 to Sept. 3, .	3.00	3.00	-	3.00	5.00	-	38.70	-	8.95	2.48	1: 4.72	890
Sept. 7 to Sept. 26, .	3.00	3.00	-	3.00	5.00	-	-	87.35	8.92	2.55	1: 6.13	864

BUTTERCUP: *Age, five years; grade, Ayrshire; last calf, Jan. 2, 1891.*

July 6 to July 21, .	3.00	3.00	-	3.00	5.00	49.75	-	-	26.42	8.34	3.17	1:6.08	807
July 24 to Aug. 2, .	3.00	-	3.00	3.00	5.00	29.60	-	-	21.74	8.73	2.49	1:6.09	840
Aug. 6 to Aug. 17, .	3.00	-	3.00	3.00	5.00	-	42.17	-	22.99	8.76	2.62	1:6.05	816
Aug. 21 to Sept. 3, .	3.00	3.00	-	3.00	5.00	-	36.58	-	21.63	8.85	2.44	1:4.70	826
Sept. 7 to Sept. 26, .	3.00	3.00	-	3.00	5.00	-	-	33.90	21.74	8.64	2.52	1:6.00	864

LUCY: *Age, five years; grade, Ayrshire; last calf, June 2, 1891.*

July 6 to July 21, .	3.00	3.00	-	3.00	5.00	49.38	-	-	28.25	12.26	2.30	1:6.23	762
July 24 to Aug. 2, .	3.00	-	3.00	3.00	5.00	44.70	-	-	26.65	12.78	2.09	1:6.52	807
Aug. 6 to Aug. 17, .	3.00	-	3.00	3.00	5.00	-	61.92	-	28.08	12.85	2.19	1:5.09	790
Aug. 21 to Sept. 3, .	3.00	3.00	-	3.00	5.00	-	58.50	-	27.28	13.26	2.06	1:4.81	798
Sept. 7 to Sept. 26, .	3.00	3.00	-	3.00	5.00	-	-	35.75	22.26	12.01	1.85	1:6.01	786

CLARISSA: *Age, seven years; grade, Durham; last calf, March 14, 1891.*

July 6 to July 21, .	3.00	3.00	-	3.00	5.00	56.69	-	-	30.63	9.49	3.23	1:6.40	889
July 24 to Aug. 2, .	3.00	-	3.00	3.00	5.00	47.60	-	-	27.59	9.31	2.96	1:6.59	923
Aug. 6 to Aug. 17, .	3.00	-	3.00	3.00	5.00	-	64.58	-	28.76	10.37	2.77	1:5.10	890
Aug. 21 to Sept. 3, .	3.00	3.00	-	3.00	5.00	-	60.07	-	27.68	10.99	2.52	1:4.81	882
Sept. 7 to Sept. 26, .	3.00	3.00	-	3.00	5.00	-	-	51.65	26.73	9.98	2.68	1:6.57	909



## TOTAL COST OF FEED PER QUART OF MILK.

*Cora.*

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Brewers' Grain consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Vetch and Oats consumed (Pounds).	Total Amount of Soya Beans consumed (Pounds).	Total Amount of Fodder Corn consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
<b>1901.</b>												
July 6 to July 21,	180.70	11.29	48.00	48.00	—	48.00	80.00	652.00	—	—	\$3 44	1.90
July 24 to Aug. 2,	113.30	11.34	30.00	—	30.00	30.00	50.00	243.00	—	—	1 92	1.69
Aug. 6 to Aug. 17,	134.88	11.24	36.00	—	36.00	36.00	60.00	—	586.00	—	3 09	2.29
Aug. 21 to Sept. 3,	161.98	11.57	42.00	42.00	—	42.00	70.00	—	600.00	—	3 55	2.19
Sept. 7 to Sept. 26,	214.19	10.71	60.00	60.00	—	60.00	100.00	—	—	749.00	4 12	1.92

*Pearl.*

July 6 to July 18,	105.46	8.11	39.00	39.00	—	39.00	65.00	593.00	—	—	\$2 89	2.74
July 24 to Aug. 2,	86.98	8.70	30.00	—	30.00	30.00	50.00	359.00	—	—	2 08	2.89
Aug. 6 to Aug. 17,	103.60	8.63	36.00	—	36.00	36.00	60.00	—	517.00	—	3 05	2.94
Aug. 25 to Sept. 3,	89.53	8.95	30.00	30.00	—	30.00	50.00	—	387.00	—	2 44	2.73
Sept. 7 to Sept. 26,	178.49	8.92	60.00	60.00	—	60.00	100.00	—	—	747.00	4 11	2.30

*Buttercup.*

July 6 to July 21,	133.50	8.34	48.00	48.00	—	48.00	80.00	700.00	—	—	\$3 50	2.62
July 24 to Aug. 2,	87.33	8.73	—	30.00	30.00	30.00	50.00	296.00	—	—	2 00	2.29
Aug. 6 to Aug. 17,	103.12	8.76	—	36.00	36.00	36.00	60.00	—	506.00	—	3 02	2.86
Aug. 21 to Sept. 3,	123.95	8.85	42.00	—	—	42.00	70.00	—	512.00	—	3 36	2.71
Sept. 7 to Sept. 26,	172.79	8.64	60.00	—	—	60.00	100.00	—	—	678.00	4 03	2.33

*Lucy.*

July 6 to July 21,	196.16	12.26	48.00	48.00	—	48.00	80.00	790.00	—	—	\$3 63	1.85
July 24 to Aug. 2,	127.79	12.78	—	30.00	30.00	30.00	50.00	447.00	—	—	2 20	1.72
Aug. 6 to Aug. 17,	154.19	12.85	—	36.00	36.00	36.00	60.00	—	743.00	—	3 54	2.30
Aug. 21 to Sept. 3,	185.58	13.26	42.00	—	—	42.00	70.00	—	819.00	—	4 03	2.17
Sept. 7 to Sept. 26,	240.12	12.01	60.00	—	—	60.00	100.00	—	—	715.00	4 07	1.69

*Clarissa.*

July 6 to July 21,	151.86	9.49	48.00	48.00	—	48.00	80.00	907.00	—	—	\$3 79	2.50
July 24 to Aug. 2,	93.14	9.31	—	30.00	30.00	30.00	50.00	476.00	—	—	2 24	2.40
Aug. 6 to Aug. 17,	124.42	10.37	—	36.00	36.00	36.00	60.00	—	775.00	—	3 62	2.91
Aug. 21 to Sept. 3,	153.84	10.99	42.00	—	—	42.00	70.00	—	841.00	—	4 08	2.65
Sept. 7 to Sept. 26,	199.53	9.98	60.00	—	—	60.00	100.00	—	—	1,033.00	4 47	2.24

## 68 AGRICULTURAL EXPERIMENT STATION. [Jan.

## NET COST OF MILK AND MANURIAL VALUE OF FEED.

*Cora.*

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
<b>1891.</b>					Cents.	Pounds.
July 6 to July 21, .	\$3 44	\$1 78	\$1 42	\$2 02	1.12	1,080
July 24 to Aug. 2, .	1 92	0 93	0 74	1 18	1.04	1,055
Aug. 6 to Aug. 17, .	3 09	1 39	1 11	1 98	1.47	1,015
Aug. 21 to Sept. 3, .	3 55	1 62	1 30	2 25	1.39	1,032
Sept. 7 to Sept. 26, .	4 12	2 00	1 60	2 52	1.18	1,020
Total, . . .	\$16 12	\$7 72	\$6 17	\$9 95	-	-

*Pearl.*

July 6 to July 18, .	\$2 89	\$1 50	\$1 20	\$1 69	1.60	972
July 24 to Aug. 2, .	2 08	1 05	0 84	1 24	1.43	945
Aug. 6 to Aug. 17, .	3 05	1 37	1 10	1 95	1.88	920
Aug. 25 to Sept. 3, .	2 44	1 12	0 90	1 54	1.72	920
Sept. 7 to Sept. 26, .	4 11	2 00	1 60	2 51	1.41	930
Total, . . .	\$14 57	\$7 04	\$5 64	\$8 93	-	-

*Buttercup.*

July 6 to July 21, .	\$3 50	\$1 82	\$1 46	\$2 04	1.53	832
July 24 to Aug. 2, .	2 00	0 98	0 78	1 22	1.40	845
Aug. 6 to Aug. 17, .	3 02	1 36	1 09	1 93	1.84	812
Aug. 21 to Sept. 3, .	3 36	1 52	1 22	2 14	1.72	850
Sept. 7 to Sept. 26, .	4 03	1 94	1 55	2 48	1.44	858
Total, . . .	\$15 91	\$7 62	\$6 10	\$9 81	-	-

*Lucy.*

July 6 to July 21, .	\$3 63	\$1 92	\$1 54	\$2 09	1.07	793
July 24 to Aug. 2, .	2 20	1 14	0 91	1 29	1.01	835
Aug. 6 to Aug. 17, .	3 54	1 61	1 29	2 25	1.46	785
Aug. 21 to Sept. 3, .	4 03	1 85	1 48	2 55	1 37	815
Sept. 7 to Sept. 26, .	4 07	1 97	1 58	2 49	1 04	765
Total, . . .	\$17 47	\$8 49	\$6 80	\$10 67	-	-

NET COST OF MILK AND MANURIAL VALUE OF FEED—*Concluded.**Clarissa.*

FEEDING PERIODS.	Total Cost of Feed consumed.	Value of Fertilizing Constituents contained in the Feed.	Manurial Value of the Feed after deducting Twenty Per Cent. taken by the Milk.	Net Cost of Feed for the Production of Milk.	Net Cost of Feed for the Production of One Quart of Milk.	Weight of Animal at Close of Period.
<b>1891.</b>					Cents.	Pounds.
July 6 to July 21, .	\$3 79	\$2 04	\$1 63	\$2 16	1.42	911
July 24 to Aug. 2, .	2 24	1 17	0 94	1 30	1.40	930
Aug. 6 to Aug. 17, .	3 62	1 65	1 32	2 30	1.85	890
Aug. 21 to Sept. 3, .	4 08	1 88	1 50	2 58	1.68	907
Sept 7 to Sept. 26, .	4 47	2 23	1 78	2 69	1.35	905
<b>Total, . . .</b>	<b>\$18 20</b>	<b>\$8 97</b>	<b>\$7 17</b>	<b>\$11 03</b>	<b>—</b>	<b>—</b>

*Statement of the Average of Analyses of Milk made during the Different Feeding Periods.*

PERIODS.		Cora.	Pearl.	Buttercup.	Lucy.	Clarissa.
I., . . .	{ Solids, per cent., { Fat, per cent., .	13.05 4.24	13.96 4.26	13.48 3.92	13.58 4.29	13.59 4.58
II., . . .	{ Solids, per cent., { Fat, per cent., .	12.70 3.98	13.55 3.83	12.59 3.28	13.48 4.26	13.16 4.17
III., . . .	{ Solids, per cent., { Fat, per cent., .	12.99 4.39	14.63 4.87	12.68 3.67	13.25 4.27	13.43 4.59
IV., . . .	{ Solids, per cent., { Fat, per cent., .	13.68 4.63	14.67 4.62	12.99 3.58	13.98 4.54	14.54 4.84
V., . . .	{ Solids, per cent., { Fat, per cent., .	13.30 3.88	14.92 4.25	13.55 3.83	14.33 4.97	14.65 4.93

*Corn Meal.*

1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	15.31	303.20	—	—	1:9.23
Dry matter, . . . . .	84.69	1,697.80	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.72	34.40	—	—	
“ cellulose, . . . . .	2.17	43.40	20.83	48	
“ fat, . . . . .	4.84	96.80	82.28	85	
“ protein (nitrogenous matter), . . . . .	12.18	243.60	192.44	79	
Non-nitrogenous extract matter, . . . . .	79.09	1,581.80	1,550.16	98	
	100.00	2,000.00	1,845.71	—	

*Gluten Meal.*

1891.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	11.11	222.20	—	—	1:2.66
Dry matter, . . . . .	88.89	1,777.80	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.65	33.00	—	—	
“ cellulose, . . . . .	0.73	14.60	9.05	62	
“ fat, . . . . .	9.22	184.40	156.74	85	
“ protein (nitrogenous matter), . . . . .	33.34	666.80	526.77	79	
Non-nitrogenous extract matter, . . . . .	55.06	1,101.20	1,002.09	91	
	100.00	2,000.00	1,694.65	—	

*Brewers' Grain.*

1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digest- ible in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.	
Moisture at 100° C, . . . .	12.00	240.00	-	-	} 1:2.95	
Dry matter, . . . . .	88.00	1,760.00	-	-		
	100.00	2,000.00	-	-		
<i>Analysis of Dry Matter.</i>						
Crude ash, . . . . .	4.46	89.20	-	-		
“ cellulose, . . . . .	15.31	306.20	122.48	40		
“ fat, . . . . .	6.10	122.00	101.26	83		
“ protein (nitrogenous matter), . . . . .	23.43	468.60	346.76	74		
Non-nitrogenous extract matter, . . . . .	50.70	1,014.00	648.96	64		
	100.00	2,000.00	1,219.46	-		

*Wheat Bran.*

1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digest- ible in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.	
Moisture at 100° C., . . .	12.99	259.80	-	-	} 1:4.73	
Dry matter, . . . . .	87.01	1,740.20	-	-		
	100.00	2,000.00	-	-		
<i>Analysis of Dry Matter.</i>						
Crude ash, . . . . .	6.23	124.60	-	-		
“ cellulose, . . . . .	10.47	209.40	50.26	24		
“ fat, . . . . .	5.37	107.40	76.25	71		
“ protein (nitrogenous matter), . . . . .	16.16	323.20	252.10	78		
Non-nitrogenous extract matter, . . . . .	61.77	1,235.40	951.26	77		
	100.00	2,000.00	1,329.87	-		

*Vetch and Oats.*

1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	64.77	1,295.40	-	-	1:10.01
Dry matter, . . . . .	35.23	704.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	7.97	159.40	-	-	
“ cellulose, . . . . .	30.77	615.40	-	-	
“ fat, . . . . .	2.58	51.60	25.80	50	
“ protein (nitrogenous matter), . . . . .	8.83	176.60	105.96	60	
Non-nitrogenous extract matter, . . . . .	49.85	997.00	997.00	100	
	100.00	2,000.00	1,128.76	-	

*Soja Beans.*

1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	72.22	1,444.40	-	-	1:5.85
Dry matter, . . . . .	27.78	555.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.39	127.80	-	-	
“ cellulose, . . . . .	31.49	629.80	365.28	58	
“ fat, . . . . .	3.39	67.80	9.49	14	
“ protein (nitrogenous matter), . . . . .	13.71	274.20	175.49	64	
Non-nitrogenous extract matter, . . . . .	45.06	901.20	549.73	61	
	100.00	2,000.00	1,099.99	-	

*Fodder Corn (Green).*

1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	71.86	1,437.20	-	-	} 1:11.19
Dry matter, . . . . .	28.14	562.80	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	3.78	75.60	-	-	
" cellulose, . . . . .	25.67	513.40	369.65	72	
" fat, . . . . .	2.24	44.80	33.60	75	
" protein (nitrogenous matter), . . . . .	7.62	152.40	114.30	75	
Non-nitrogenous extract matter, . . . . .	60.69	1,213.80	825.38	68	
	100.00	2,000.00	1,342.93	-	

4. *Creamery Record of the Station for the Years  
1890 and 1891.*

The cost of feed consumed is based on the market price of the various ingredients, as is stated in the subsequent table.

The valuation of the whole milk is taken at three cents per quart. The estimates of the value of fertilizing ingredients contained in the feed are based on those given in the following table.

The local market value and the value of the essential fertilizing constituents of the fodder articles used are reckoned for the year 1890, in order to render the results comparable.

*Local Market Value per Ton of the Various Articles of Fodder  
used.*

Corn meal, . . . . .	\$23 00
Wheat bran, . . . . .	21 50
Gluten meal, . . . . .	23 00
Brewers' grain, . . . . .	22 00



*Local Market Value per Ton, etc. — Concluded.*

New-process linseed meal, . . . . .	\$26 00
Old-process linseed meal, . . . . .	27 00
Cotton-seed meal, . . . . .	26 00
Hay, . . . . .	15 00
Rowen, . . . . .	15 00
Corn fodder, . . . . .	5 00
Corn stover, . . . . .	5 00
Corn ensilage, . . . . .	2 25
Corn and soja bean ensilage, . . . . .	3 50
Soja bean (green), . . . . .	4 40
Vetch and oats (green), . . . . .	2 75
Fodder corn (green), . . . . .	2 50
Carrots, . . . . .	7 00
Sugar beets, . . . . .	5 00
Cabbages, . . . . .	2 50

*Valuation of the Essential Fertilizing Constituents of the Various Articles of Fodder used.*

Nitrogen, 16½ cents; phosphoric acid, 6 cents; potassium oxide, 4½ cents per pound.

	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Valuation per Ton.
Corn meal, . . . . .	1.86	0.77	0.45	\$7 44
Wheat bran, . . . . .	2.82	3.05	1.49	14 24
Gluten meal, . . . . .	5.22	0.40	0.05	17 75
Brewers' grain, . . . . .	3.299	1.192	1.466	13 56
New-process linseed meal, . . . . .	6.25	1.42	1.16	23 32
Old-process linseed meal, . . . . .	5.33	1.64	1.16	20 54
Cotton-seed meal, . . . . .	6.467	*2.33	1.723	25 60
Hay, . . . . .	1.25	0.464	2.085	6 46
Rowen, . . . . .	1.93	0.364	2.86	9 24
Corn fodder (dry), . . . . .	1.37	0.368	0.355	5 26
Corn stover (dry), . . . . .	0.78	0.09	0.599	3 19
Corn ensilage, . . . . .	0.36	0.14	0.33	1 64
Corn and soja bean ensilage, . . . . .	0.708	0.42	0.444	3 22
Soja bean (green), . . . . .	0.590	0.193	0.311	2 44
Vetch and oats (green), . . . . .	0.23	0.09	0.79	1 54
Fodder corn (green), . . . . .	0.343	0.195	0.43	1 73
Carrots, . . . . .	0.14	0.10	0.54	1 04
Sugar beets, . . . . .	0.29	0.03	0.18	1 15
Cabbages, . . . . .	0.300	0.11	0.43	1 48

The value of cream is that granted us from month to month by our local creamery association. The station has no other connection with the financial management of the creamery.

Our presentation of financial results is based on the local cost of feed alone, and does not consider interest on investment and labor involved, for the reason that approximate estimates on these points are in an exceptional degree dependent on quality of stock and varying local circumstances. The details are embodied in a few subsequent tables under the following headings:—

1. Statement of articles of fodder used.
2. Record of average quality of milk and of fodder rations.
3. Value of cream produced at creamery basis of valuation.
4. Cost of skim-milk at the selling price of three cents per quart of whole milk.
5. Fertilizing constituents of cream.
6. Some conclusions suggested by the records.
7. Analyses of cream, and modes of analysis of milk, cream and butter.

*Statement of Articles of Fodder used during 1890 (in Pounds).*

	Corn Meal.	Wheat Bran.	Gluten Meal.	Old-process Lined Meal.	New-process Lined Meal.	Cotton-seed Meal.	Hay.	Rowen.	Fodder Corn.	Corn Clover.	Corn Rumlage.	Velch and Oats.	Boja Beans.	Carrots.	Sugar Beets.
January,	604.50	604.50	-	604.50	-	-	1,016.00	-	-	-	7,737.50	-	-	-	-
February,	370.50	546.00	-	529.75	-	-	514.00	-	860.50	-	4,687.50	-	-	1,080.00	-
March,	-	604.50	-	604.50	-	-	-	-	1,132.00	1,665.00	-	-	-	3,680.00	-
April,	184.50	577.50	-	106.50	444.00	-	977.00	-	1,201.50	472.50	-	-	-	2,620.00	1,080.00
May,	604.50	604.50	-	340.50	262.50	-	2,656.50	360.00	-	-	-	-	-	-	3,240.00
June,	585.00	585.00	-	379.50	204.00	-	-	3,723.50	-	-	-	-	-	-	-
July,	604.50	604.50	-	-	604.50	-	725.50	613.00	-	-	-	7,463.00	-	-	-
August,	604.50	604.50	-	-	604.50	-	930.00	-	-	-	-	910.50	8,882.50	-	-
September,	585.00	585.00	-	-	585.00	-	120.00	2,935.00	-	-	-	-	1,767.00	-	-
October,	571.50	571.50	-	-	233.50	348.00	-	3,221.50	-	-	-	-	-	-	-
November,	450.00	450.00	120.00	-	-	830.00	-	3,555.50	-	-	-	-	-	-	-
December,	465.00	465.00	255.00	-	-	210.00	-	3,225.00	-	-	-	-	-	-	-







## 3. Value of Cream at Creamery Basis of Valuation.

	Total Cost of Feed consumed.	Total Value of Fertilizing Constituents of Food consumed.	Value of Fertilizing Constituents lost in Cream.	Net Cost of Feed for Production of Cream.	Value of Cream produced.
<b>1900.</b>					
January, . . . . .	\$37 78	\$23 07	\$0 64	\$15 35	\$33 99
February, . . . . .	32 19	19 62	0 69	13 26	36 93
March, . . . . .	34 38	19 75	0 66	15 29	37 52
April, . . . . .	38 54	19 75	0 68	19 47	32 40
May, . . . . .	52 09	25 32	0 73	27 60	33 45
June, . . . . .	48 63	30 05	0 72	19 30	30 66
July, . . . . .	41 65	23 90	0 68	18 43	29 04
August, . . . . .	49 09	27 52	0 73	22 30	39 27
September, . . . . .	47 43	28 68	0 72	19 47	42 05
October, . . . . .	44 48	27 82	0 65	17 31	39 92
November, . . . . .	42 36	26 59	0 58	16 35	34 83
December, . . . . .	40 20	24 89	0 54	15 85	32 84
Averages, . . . . .	\$42 40	\$24 75	\$0 67	\$18 32	\$35 24
<b>1901.</b>					
January, . . . . .	\$41 79	\$26 14	\$0 60	\$16 25	\$35 23
February, . . . . .	36 98	26 85	0 61	10 74	25 49
March, . . . . .	27 86	17 66	0 69	10 89	42 44
April, . . . . .	35 96	23 22	0 63	13 37	37 36
May, . . . . .	43 70	26 64	0 74	17 80	40 82
June, . . . . .	35 80	21 51	0 68	14 97	32 40
July, . . . . .	36 76	21 30	0 66	16 12	32 26
August, . . . . .	44 88	25 92	0 68	19 64	36 26
September, . . . . .	33 64	20 11	0 68	14 21	41 84
October, . . . . .	43 18	22 30	0 63	21 51	39 48
Averages, . . . . .	\$38 06	\$23 17	\$0 66	\$15 56	\$37 36

4. *Cost of Skim Milk at the Selling Price of Three Cents per Quart for Whole Milk.*

	Quarts of Milk produced.	Spaces of Cream.	Quarts of Cream (One Quart equals 3.4 Spaces).	Quarts of Skim-milk.	Value of Cream per Space (Cents).	Value of Cream per Quart of Milk (Cents).	Total Value of Cream.	Cost of Skim-milk per Quart (Whole Milk at ThreeCentsper-Quart).	Total Cost of Skim-milk.
<b>1890.</b>								Cents.	
January, .	1,404.1	971	285.6	1,118.5	3.50	2.42	\$33 99	0.73	\$8 13
February, .	1,596.2	1,065	310.3	1,285.9	3.50	2.31	36 93	0.85	10 96
March, .	1,594.8	1,014	298.2	1,296.6	3.70	2.35	37 52	0.80	10 32
April, .	1,720.8	1,036	304.4	1,416.4	3.13	1.88	32 40	1.36	19 22
May, .	1,946.7	1,116	327.9	1,618.8	3.00	1.72	33 45	1.54	24 95
June, .	1,922.4	1,095	322.1	1,800.3	2.80	1.59	30 66	1.69	27 01
July, .	1,727.0	1,037	305.0	1,422.0	2.80	1.68	29 04	1.60	22 77
August, .	1,809.5	1,122	330.0	1,479.5	3.50	2.17	39 27	1.02	15 02
September, .	1,747.4	1,098	322.9	1,424.5	3.83	2.41	42 05	0.73	10 37
October, .	1,556.9	999	293.5	1,263.4	4.00	2.56	39 92	0.54	6 79
November, .	1,413.5	893	262.6	1,150.9	3.90	2.46	34 83	0.66	7 57
December, .	1,321.6	821	241.5	1,080.1	4.00	2.48	32 84	0.61	6 81
Averages, .	1,646.7	1,021	300.3	1,346.4	3.47	2.17	\$35 24	1.01	\$14 16
<b>1891.</b>									
January, .	1,413.5	915	269.1	1,144.4	3.85	2.49	\$35 23	0.63	\$7 18
February, .	1,643.8	934	274.7	1,369.1	3.80	2.16	35 49	1.01	13 82
March, .	1,700.2	1,048	308.2	1,392.0	4.05	2.50	42 44	0.62	8 57
April, .	1,468.1	958	281.8	1,186.3	3.90	2.54	37 36	0.56	6 68
May, .	1,889.7	1,134	333.2	1,556.5	3.60	2.16	40 82	1.02	15 87
June, .	1,841.3	1,045	307.4	1,533.9	3.10	1.76	32 40	1.49	22 84
July, .	1,791.2	1,008	296.5	1,494.7	3.20	1.80	32 26	1.44	21 48
August, .	1,924.0	1,036	304.7	1,619.3	3.50	1.88	36 26	1.33	21 46
September, .	1,826.9	1,046	307.8	1,519.1	4.00	2.29	41 84	0.85	12 97
October, .	1,659.9	963	283.2	1,376.7	4.10	2.38	39 48	0.75	10 32
Averages, .	1,715.9	1,009	296.7	1,419.2	3.71	2.20	\$37 36	0.97	\$14 12

5. *Fertilizing Constituents of Cream.*

[Average analysis.]

	Per Cent.
Moisture at 100° C., . . . . .	75.22
Nitrogen (16½ cents per pound), . . . . .	.54
Potassium oxide (4½ cents per pound), . . . . .	.123
Phosphoric acid (6 cents per pound), . . . . .	.168



### 6. *Conclusions.*

1. The nutritive ratio of the feed varied in 1890 from 1 : 4.60 to 1 : 6.25, with an average of 1 : 5.19; in 1891 from 1 : 4.17 to 1 : 6.74, with an average of 1 : 5.17.

2. The amount of fat in the milk varied in 1890 from 4.38 per cent. to 5.09 per cent., with an average of 4.70 per cent.; in 1891 it varied from 4.15 per cent. to 5.21 per cent., with an average of 4.68 per cent.

3. The percentage of total solids varied in 1890 from 13.37 to 14.80; in 1891 from 13.41 to 14.99, with an average for 1890 of 13.99 and for 1891 of 14.18.

4. The total cost of feed for one quart of cream amounts in 1890 to 14.12 cents, and in 1891 to 12.83 cents.

5. The net cost of feed for one quart of cream amounts in 1890 to 6.10 cents, and in 1891 to 5.24 cents.

6. The value received for one space of cream varied in 1890 from 3 to 4 cents, with an average of 3.47 cents; in 1891 from 3.10 to 4.10 cents, with an average of 3.71 cents, which amounts per quart (average) in 1890 to 11.80 cents and in 1891 to 12.61 cents.

7. The number of quarts of milk required to produce one space of cream in 1890 was 1.61, and in 1891, 1.70, or 5.47 quarts of whole milk to produce one quart of cream in 1890 and 5.78 quarts to produce one quart of cream in 1891.

8. The net cost of feed per quart of cream averages in 1890, 6.10 cents and in 1891, 5.24 cents. We received per quart of cream in 1890, 11.80 cents and in 1891, 12.61 cents, thereby securing a profit of 5.70 cents per quart in 1890 and 7.37 cents in 1891.

From these statements it appears, as has already been claimed in previous reports, that close fodder rations tend to improve the quality of the milk as well as the condition of the animal. The introduction of dried brewers' grain and cotton-seed meal into the daily diet has apparently lowered to a considerable extent the net cost of feed.

For further details concerning results in preceding years, see seventh annual report, pages 82 to 84, and also eighth annual report, pages 54 to 65.

Our average statements for the current year apply in each case to only ten months, due to the fact that financial settlement with our local creamery is made two months after cream is furnished.

7. Creamery Record, 1891. — *Analyses of Cream and Butter Fat.*

DATE OF SAMPLING.	ANALYSIS OF CREAM.			ANALYSIS OF FAT.		AVERAGE DAILY FODDER RATIONS.
	Solids.	Fat.	Solids not Fat.	Vola- tile Acids.	Non- volatile Acids.	
1891.						
Jan. 20, .	27.14	18.54	8.60	7.54	84.49	3 pounds corn meal, 3 pounds wheat bran, 3 pounds cotton- seed meal, 10 pounds rowen, 16 pounds mixed ensilage (corn and soja beans).
" 30, .	29.35	19.60	9.75	6.72	86.98	
Feb. 3, .	27.57	18.60	8.97	6.78	86.48	3 pounds corn meal, 3 pounds wheat bran, 3 pounds cotton- seed meal, 5 pounds rowen, 45 pounds mixed ensilage.
" 10, .	27.53	19.17	8.36	7.43	86.25	
Feb. 17, .	28.26	19.88	8.38	7.49	86.30	3 pounds corn meal, 3 pounds wheat bran, 3 pounds gluten meal, 5 pounds rowen, 50 pounds mixed ensilage.
" 24, .	27.41	20.76	6.65	7.82	86.10	
March 3, .	27.29	19.34	7.95	-	-	
March 11, .	26.82	18.98	7.84	-	-	3 pounds corn meal, 3 pounds wheat bran, 3 pounds gluten meal, 15 pounds corn stover.
" 17, .	26.53	18.63	7.90	-	-	
" 24, .	24.65	16.73	9.92	-	-	
March 31, .	24.74	17.53	7.21	6.14	88.89	3 pounds corn meal, 3 pounds wheat bran, 3 pounds cotton- seed meal, 15 pounds corn stover.
April 7, .	26.63	18.58	8.05	6.24	87.89	
" 13, .	26.75	18.84	7.91	6.52	88.32	
April 21, .	25.95	18.09	7.86	-	-	3 pounds corn meal, 3 pounds wheat bran, 3 pounds cotton- seed meal, 20 pounds rowen.
" 28, .	26.61	18.98	7.63	-	-	
May 5, .	27.36	19.56	7.80	-	-	
May 12, .	26.32	18.63	7.69	-	-	3 pounds corn meal, 3 pounds wheat bran, 3 pounds gluten meal, 18 pounds rowen.
" 19, .	25.68	18.11	7.57	-	-	
" 26, .	28.01	20.09	7.92	-	-	
July 14, .	24.65	17.30	7.35	-	-	3 pounds corn meal, 3 pounds brewers' grain (dry), 3 pounds gluten meal, 5 pounds rowen, 45 pounds vetch and oats (green).
" 23, .	24.27	16.45	7.82	-	-	
Aug. 11, .	25.21	18.12	7.09	-	-	3 pounds corn meal, 3 pounds wheat bran, 3 pounds gluten meal, 5 pounds rowen, 42 pounds soja beans (green).
" 18, .	25.93	18.41	7.52	-	-	

*Creamery Record, 1891. — Analyses of Cream of Butter.*

DATE OF SAMPLING.	Solids.	Fat.	Solids not Fat.	AVERAGE DAILY FODDER RATIONS.
<b>1891.</b>				
Aug. 25, .	27.44	19.27	8.17	3 pounds corn meal, 3 pounds brewers' grain (dry), 3 pounds gluten meal, 5 pounds rowen, 42 pounds soja beans (green).
Sept. 1, .	25.52	18.15	7.37	
Sept. 15, .	23.01	15.69	7.32	3 pounds corn meal, 3 pounds brewers' grain, 3 pounds gluten meal, 5 pounds rowen, 35 pounds fodder corn (green).
" 22, .	25.18	17.56	7.62	
Dec. 8, .	22.15	15.67	6.48	3 pounds maize feed, 3 pounds cotton-seed meal, 3 pounds wheat bran, 16 pounds sweet corn stover.
" 15, .	25.03	18.14	6.89	
" 22, .	24.33	17.71	6.62	
Dec. 29, .	25.97	18.66	7.31	3 pounds maize feed, 3 pounds cotton-seed meal, 3 pounds wheat bran, 14 pounds dent corn stover.

*Method of Milk Analysis.*

**Total Solids.** — Evaporate a known quantity of milk (approximately 5 grams) in a weighed porcelain dish, containing 15 to 20 grams of pure, dry sand, on the water bath until apparently dry, then transfer to the air bath and dry at 100° to 105° C. to a constant weight, weighing at intervals of about an hour. In case of cream, use 2.5 to 3 grams for evaporation.

**Fat.** — Pulverize the sand containing the solids without removing from the dish, subsequently transfer to a filter, and exhaust with anhydrous, alcohol-free ether. Dry the fat obtained on the evaporation of the ether in an air bath at 100° to 105° C. to a constant weight.

**Ash.** — A weighed quantity of milk is evaporated to dryness with a few drops of nitric acid, and burned in a muffle at a low red heat until free from carbon.

*Methods of Butter Analysis.*

(1) **Moisture.** — Two and five-tenths to 3 grams are dried at 100° C. in an air bath.

(2) **Salt.** — Six to 7 grams of the butter are washed into a separatory funnel with hot water, and are well shaken, and

allowed to stand until the fat has collected on top; the water is then drawn off, and a fresh quantity added, and shaken up with the butter. This is continued until 200 to 300 cubic centimetres of water have passed through the funnel. The washings are mixed, and made up to 500 cubic centimetres, and the chlorine determined in an aliquot part by means of silver nitrate. From the chlorine the salt is readily calculated.

(3) *Fat*. — Two and five-tenths to 3 grams of the fat freed from salt by the above operation (2), and from water by drying in the air bath, are dissolved in ether, and filtered from the curd into a tared flask. The ether is driven off, and the residual fat dried and weighed. In calculating the per cent., allowance is made for salt and water removed.

(4) *Casein*. — The residue remaining on the filter in (3) is tested for nitrogen by the Kjeldahl method. The factor 6.33 is used in reducing the per cent. of nitrogen found to casein.

*Method for determining Volatile and Non-volatile Fatty Acids  
contained in Butter.*

The sample is prepared by churning the cream in a suitable bottle, washing the butter well with cold water, melting at 50° C. and filtering from the curd through a hot-water funnel. The fat is then heated in the air bath until free from water.

The method pursued in the determination of the volatile and non-volatile fatty acids is essentially that described by L. F. Nilson, in "Zeit. f. Anal. Chemie," 28, 2, 176.

Two and eight-tenths cubic centimetres to 2.9 cubic centimetres (approximately 2.5 grams) are measured into a tared Erlenmeyer flask of 250 cubic centimetres capacity, and the exact weight determined. Saponification is accomplished by adding 1 gram of potassium hydrate dissolved in 2 cubic centimetres of water, and 5 cubic centimetres of strong (95 per cent.) alcohol. The flask is provided with a reflux condenser, and heated until saponification is complete. The alcohol is then driven off, the last traces being removed by means of the following device: the flask is provided with a double perforated rubber cork, one hole carrying a glass tube reaching nearly to the bottom of the flask and provided

above with a short rubber tube carrying a pinch-cock, the other connected by means of a rubber tube with a suction pump. By alternately opening and closing the pinch-cock while the pump is working, the last traces of alcohol can be readily removed from the soap.

Dissolve the soap thus obtained in 30 cubic centimetres of warm water, decompose with 20 cubic centimetres of a 20 per cent. solution of orthophosphoric acid, distil off the volatile acids through a condenser, filtering the distillate, and titrate with decinormal sodium hydrate, using phenolphthalein as indicator. The volatile acids are expelled from the flask by a current of steam. When the distillate amounts to 500 cubic centimetres, the operation is considered to be complete. The volatile acids are calculated as butyric.

The condenser and connections are rinsed back into the flask with boiling water, and the non-volatile acids washed with hot water, and filtered when cool through the same filter that was used for the distillate. The washing is continued until no traces of phosphoric acid are left in the distillate. The filter is then exhausted with hot alcohol, allowing the solution to run into the flask. The alcohol is driven off on the water bath, and the non-volatile fatty acids dried at 100° C. in the air bath until they begin to gain weight.

### 5. *Some General Remarks on Analysis of Fodder and Fodder Analyses.*

The application of an intelligently devised system of chemical tests, for the purpose of ascertaining the amount and the relative proportions of the essential proximate constituents of our fodder articles, has rendered valuable services to practical agriculture. The chemical analysis of plants during their successive stages of growth has shown marked alterations in their composition, as far as the *absolute amount* of vegetable matter, as well as the *relative proportion* of the essential plant constituents, are concerned. It has rendered not less conspicuous the important influence which the soil in its varying state of fertility exerts on the quantity and the quality of the growth raised upon it. The lessons derived from this source of information have stimulated inquiries concerning the safest modes of manuring, of

cultivating and of harvesting our different farm crops with the prospect of securing the most satisfactory returns under existing circumstances.

A better knowledge regarding the particular quality of the various articles of fodder at our disposal improves our chances of supplementing them judiciously and thus economically for different kinds of farm live-stock, as well as for different conditions and functions of the same kind. It furnishes, also, a safer basis for the explanation of the results obtained in actual feeding experiments. To study the nutritive value or feeding effect of any of our fodder articles by actual feeding experiments, without learning, as far as practicable, something more definite regarding its peculiar quality or composition, deprives the results obtained largely of their general interest, for they are secured under ill-defined circumstances. The chemical analysis of an article of fodder is for these reasons considered the first step required to render an intelligent interpretation of the results in feeding trials possible.

*Food Constituents.*—Actual feeding experiments have shown that *three groups of plant constituents*, namely, *nitrogenous, non-nitrogenous and mineral constituents*, are needed to successfully sustain animal life. No one or two of them, alone, can support it for any length of time. In case the food does not contain digestible non-nitrogenous substances, the fat and a portion of the muscles of the animal on trial will be consumed in the support of respiration before its life terminates. In case digestible nitrogenous constituents are excluded from the diet, the formation of new blood and flesh from the food consumed ceases; for the animal system, according to our present state of information, is not capable of producing its principal constituents from anything else than the nitrogenous constituents of the plants.

Herbivorous animals receive these substances directly from the plants; carnivorous animals indirectly, by feeding on herbivorous animals. We feed, at present, our farm-stock too frequently, without a due consideration of the general natural law of nutrition; to deal out our fodder crops only with mere reference to name, instead of making ourselves more familiar with their composition and their

particular quality, deprives us even of the chance of drawing an intelligent conclusion from our present system of feeding.

To compound the animal diet with reference to the particular organization of the animal, its age and its functions, is of no more importance than to select the fodder substances with reference to its special wants, as far as the absolute and relative quantity of the three essential groups of food constituents are concerned.

The peculiar character of our home-raised fodder articles is apt to conceal their special deficiency for the various purposes they are used for in general farm management. They all contain the three essential food constituents, yet in widely varying proportions; and they ought, therefore, to be supplemented in different directions to secure their full economical value. To resort to more or less of the same fodder article to meet the special wants may meet the case as far as an efficient support of the animal is concerned, yet it can only in exceptional cases be considered good economy.

*Fodder Rations.*—To satisfy the craving of the stomach and to feed a nutritious food are both requirements of a healthy animal diet, which, each in its own way, may be complied with. The commercial fodder substances—as oil-cakes, mill refuse brans, and our steadily increasing supply of refuse materials from breweries, starch works, glucose factories, etc.—are admirably fitted to supplement our farm resources for stock feeding; they can serve in regard to animal growth and support, in a similar way as the commercial fertilizers in the growth of our farm crops, by supplementing our home manurial resources. To feed an excess of food materials, as roots, potatoes, etc., which contain a large proportion of non-nitrogenous matter, as starch, sugar, digestible cellular substance, etc., means direct waste, for they are ejected by the animal, and do not even materially benefit the manure heap. In case of an excessive consumption of nitrogenous constituents, — as oil-cakes, brans, gluten meal, etc., — a part of the expense is saved in an increased value of the manure obtained, yet scarcely enough to recommend that practice beyond merely exceptional cases. The aim, therefore, of an economical stock-feeding must be to compound our

various fodder materials in such a manner that the largest quantity of each of the three above-stated groups of fodder substances, which the animal is capable of assimilating, should be contained in its daily diet to meet the purpose for which it is kept.

To compound the fodder rations of our farm stock, with reference to the special wants of each class of them, is an essential requirement for a satisfactory performance of their functions; to supply these wants in an economical way controls the financial success of the industry. From these and similar considerations it will be apparent that the development of a more rational, and thus more economical, system of feeding farm live-stock requires the following kind of information:—

*First.* How much of each of the three essential groups of food constituents is contained in the fodder we feed?

*Second.* How much of each of these essential food constituents is digestible under existing circumstances, and is thus directly available to the particular animal on trial?

*Third.* How much of each of the three essential food constituents does each kind of animal require to secure the best results?

More than twenty-five years have passed by since these questions have seriously engaged the attention of skilful experimenters. Sufficient valuable information has been secured in the course of time to encourage the use of the adopted methods of observation, and to impart to many of the conclusions arrived at a just claim for a serious consideration on the part of practical agriculturists. The fact that much needs still to be learned to meet the reasonable expectations of those engaged in the development of a more economical system of feeding farm live-stock cannot be considered a valid reason why we should not make an intelligent use of what we have learned.

*Fodder Analysis.*—The chemical analysis of a fodder article is carried on with a view to determine the quantity of each group of its constituents, which is considered an essential ingredient of a complete food for the support of animal life. Our modes of analyzing articles of fodder are



practically the same, wherever this work is carried out intelligently. The results obtained are, therefore, applicable for the determining of a comparative value wherever the identity of the material can be established.

The actual results of the analysis are usually reported under the following headings: —

1. Amount of moisture lost at 110° C., or 230° F., and amount of dry matter left behind.

2. Amount of mineral matter left behind after a careful incineration of the material.

3. Amount of organic nitrogenous matter, commonly called crude protein.

4. Amount of non-nitrogenous organic matter, exclusive of fat and of coarse cellulose substances.

The entire mass which any fodder substance leaves behind after being heated at one hundred and ten degrees, Centigrade thermometer, is called dry matter. An increase in dry substance in case of any plant or part of plant at the same stage of growth indicates usually a higher feeding value. To satisfy the cravings of the animal, a certain quantity or bulk of coarse, dry matter becomes an important consideration in making up the fodder rations for different classes of animals. In raising young stock for fattening purposes, a liberal supply is also desirable, to effect a proper distension of the digestive organs, to make them good feeders hereafter.

Nitrogenous substances, or protein matter, refer to several groups of nitrogen-containing compounds, of plants in particular, as albumin, fibrin, legumin, basein, etc., which are essential for the formation of blood and tissues. Those contained in animal matter, as meat refuse, are frequently considered of a higher value than those in many plants.

Non-nitrogenous substances include, in particular, starch, sugars, organic acids, gums, fats and the digestible portion of the cellular matter of the fodder. These substances are readily transformed within the digestive organs into soluble compounds of a similar chemical character, and are thus assumed to serve an identical physiological purpose. As more recent investigations have shown a superior physio-

logical value of fat, — one of the non-nitrogenous constituents, — two and one-half times as much as starch, sugar, and other representatives of that group, its amount is separately recorded. The same course, for similar reasons, has of late been adopted with reference to certain forms of nitrogenous organic constituents of fodder articles.

Fatty substances include all the various natural fats of the plant. Most plants contain more than was assumed at an earlier stage of inquiry. As the fat is separated by means of ether, the statements in the analyses do not exactly express the amount of fatty matter alone, but include more or less resinous substances, wax, etc., which are largely soluble in ether, and of a similar highly carbonaceous character. The fat of the fodder seems to serve, in case of judicious fodder rations, mainly to increase the stock of fat in the animal which consumes the fodder.

*Digestibility of Fodder.* — Wherever the article has been tested by actual feeding experiment under skilful observation, the amount of each essential group of food constituents which has been shown to be digestible is reported in connection with the chemical analysis, under the heading *Digestible Portion*, per hundred weight or per ton. The higher or lower degree of digestibility of a fodder article exerts a decided influence on its nutritive value. Different stages of growth affect the rates of digestibility of the various plant constituents. The same feature is noticed in regard to different parts of plants, as well as in case of different kinds of animals.

More than two hundred fodder articles have thus far been studied under varying circumstances, and most of our current kinds of fodders have been tested in Europe and elsewhere, in numerous well-conducted feeding experiments with a suitable selection of different kinds of farm live-stock. This fact imparts to many of the results recorded a sufficient importance to recommend them as a basis of new feeding trials, with feed stuffs raised in our climate, or obtained in our home industries.

*Nutritive Ratio.* — The last, but not least important, column of the statement of the chemical analysis — quite

frequently found in the general record of a fodder for a practical agricultural purpose — is that of “Nutritive Ratio.” These words are used to express the numerical relation of its *digestible nitrogenous substances* taken as one, as compared with the sum of its *digestible non-nitrogenous organic substances*, fat included. The information derived from that statement is very important; for it means to express the summary of results secured by actual feeding trials under specified conditions, and with the aid of the best endorsed chemical modes to account for the constituents of the food before and after it has served for the support of the animal on trial.

Experience has shown that different kinds of animals, as well as the same kind at different ages and for different functions, require a different proportion of the essential groups of food constituents to produce in each case the best results. A statement of the nutritive ratio of a fodder article — otherwise well adapted as an ingredient of a daily diet in the case under consideration — indicates the direction in which the material has to be supplemented to economize to a full extent its various constituents.

Practical trials with milch cows have demonstrated that they require for the highest production of a good milk and the maintenance of a healthy live weight, the most nutritious food we are in the habit of giving to full-grown farm animals. Careful examinations into the composition of an efficient diet for milch cows have shown that it contains one part of digestible nitrogenous matter to from five to five and a half parts of digestible non-nitrogenous organic matter. A due consideration of these facts renders it but natural that a good corn ensilage, which has a nutritive ratio of from 1 to 10 to 1 to 12, needs a liberal addition of substances like oil-cakes, wheat bran, gluten meal, etc., which have a nutritive ratio of 1 to from 2.5 to 4, to secure its full value as an ingredient of a daily diet in the dairy; or that good hay shows less the beneficial effects of an addition of these valuable waste products than that of an inferior quality. The nutritive ratio of hay may vary from 1 to 5.5 to from 1 to 9 or more.

*Market Cost and Food Value.* — *The value of an article of fodder may be stated from two different stand-points, — that is, with reference to its cost in the local market and with reference to its nutritive feeding value. The market price may be expressed by a definite sum for each locality; it depends on demand and supply in the market, and it is beyond the control of the individual farmer. The nutritive value, or commonly called food value, of the article cannot be expressed by a definite sum; it varies with a more or less judicious application, and depends also, to a considerable degree, on its adaptation under varying circumstances. To secure the most satisfactory returns from feeding our home-raised fodder crops is as important a question as that of raising them in an economical manner. The great progress which has been made of late in regard to the proper mode of feeding plants ought to serve as an encouragement to undertake the task of inquiring more systematically into the proper mode of feeding our farm live-stock in the most profitable way.*

*Manurial Value of Fodder Articles.* — Assuming a similar degree of adaptation of the various fodder articles offered for our choice, the question of cost deserves a serious consideration, when feeding for profit. *The actual cost of a fodder article does not depend merely upon its market price, but is materially affected by the value of the manurial refuse it leaves behind, when it has served its purpose as food. The higher the percentage of nitrogen, phosphoric acid and potash a diet contains, the more valuable is the manure it furnishes, under otherwise corresponding circumstances. An excess, therefore, of any one or of all three in one diet, as compared with that of another, counts in favor of that particular diet as far as the net cost of feed is concerned; for it is admissible, for mere practical, economical purposes, to assume that, in raising one and the same kind of animals to a corresponding weight, or feeding them for the same purpose, a corresponding amount of nitrogen, phosphoric acid, potassium oxide, etc., will be retained, and, according to circumstances, either stored up in the growing animal or passed into the milk, etc. The commercial value of the three*

above-mentioned essential articles of plant food, contained in the manure secured in connection with our feeding experiments with milch cows, has differed in case of different diets from less than one-third to more than one-half of the market cost of feed consumed.

As the financial success in a mixed farm management depends, in a considerable degree, on the amount, the character and the money value of the manurial refuse material secured in connection with the special farm industry carried on, it needs no farther argument to prove that the relations which exist between the composition of the fodder and the value of the manure resulting deserve the careful consideration of the farmer when devising an efficient and, at the same time, an economical diet for his live-stock. To assist in a due consideration of this important circumstance a compilation of analyses of a great variety of fodder articles made in the course of years at the Massachusetts Experiment Station has been added to this report in the form of an appendix.

*Valuation of Concentrated Commercial Feed Stuff.*—Most of our concentrated feed stuffs, as oil-cakes, brans, middlings, maize feed, gluten meals, starch feed, etc., are by-products of various branches of industry. The articles contain, as a rule, a more liberal amount of nitrogenous food constituents than the materials from which they are obtained, and they are usually bought for the purpose of raising the nitrogen-containing food constituents of the daily diet of our farm live-stock to a desired proportion. This general practice is based on the circumstance that the larger portion of our home-raised coarse fodder articles, as meadow hay, fodder corn, corn stover, corn ensilage, roots, etc., is, comparatively speaking, quite deficient in nitrogen-containing food constituents, to meet, in an economical way, the requirement of an efficient daily diet for dairy stock, hard-worked animals, young farm live-stock of various kinds, etc. The concentrated commercial feed stuffs, if judiciously selected and in a proper mechanical condition, are admirably adapted to add to our home-raised coarse fodder articles that food constituent in which they are de-

ficient, without increasing in an objectionable degree the bulk or volume of the daily fodder ration. They tend thereby to increase, as a rule, materially, the nutritive value of our home-raised coarse fodder articles. Farmers that do not raise a liberal proportion of clover-like fodder plants are, in a particular degree, in need of concentrated commercial feed stuffs rich in nitrogenous food constituents to turn the excess of the non-nitrogenous food constituents, which most of our current home-raised coarse fodder articles contain, to the best possible account.

As we buy, in the majority of cases, the concentrated commercial feed stuffs on account of their large proportion of nitrogen-containing food constituents, it becomes of special interest to know at what cost a given quantity of digestible nitrogen-containing food constituents can be bought in the form of different feed stuffs equally well adapted under existing circumstances. A change in the market cost of one and the same commercial feed stuff affects the cost of the nitrogen-containing food constituent, in particular as its supply is more limited than that of the non-nitrogenous food constituents, which our home-raised coarse fodder articles contain, as a rule, in abundance.

The subsequent tabular statement assumes a constant cost of digestible non-nitrogenous food constituents, — sugar, starch, fat, etc., — and shows thereby the variations in the cost of digestible nitrogen-containing food constituents in case of some prominent concentrated commercial feed stuffs in our local market.

The majority of the analyses stated is made of fodder articles which have been used either during the past year in connection with some of our feeding experiments, or have been raised upon the grounds of the station. Some articles sent on by outside parties are added, on account of the special interest they may present to others.

*Valuation of Fodder Articles on the following Basis.*

Digestible cellulose and nitrogen free extract matter, 1.00 cent per pound; digestible fat, 2.50 cents per pound. The value of digestible protein determined the difference of the sum of both and the market cost of the fodder articles. (Calculation is based on dry matter, 2,000 pounds.)

	Market Cost.	Protein per Pound.
		Cents.
Corn meal, . . . . .	\$31 00	6.88
Corn meal, . . . . .	29 00	5.84
Corn meal, . . . . .	24 00	3.24
Corn meal, . . . . .	23 00	2.72
Wheat middlings, . . . . .	20 00	3.13
Spring wheat bran, . . . . .	19 00	3.04
Winter wheat bran, . . . . .	21 00	3.98
Chicago maize feed, . . . . .	23 00	2.34
Dried brewers' grain, . . . . .	22 00	3.37
Old-process linseed meal, . . . . .	26 00	2.20
New-process linseed meal, . . . . .	27 00	2.68
Chicago gluten meal, . . . . .	28 00	2.46
Cotton-seed meal, . . . . .	28 00	2.34
English hay, . . . . .	12 00	1.36
English hay, . . . . .	15 00	4.12
Rowen, . . . . .	12 00	1.21
Rowen, . . . . .	15 00	3.24
Corn stover,* . . . . .	5 00	-
Corn ensilage,* . . . . .	2 50	-
Mangold roots,* . . . . .	3 00	-
Sugar beets,* . . . . .	5 00	-

\* The value of the digestible cellulose, nitrogen free extract matter and fat, on the above basis, exceeds the market cost.

	CORN MEAL.				WHEAT MIDDINGS.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Moisture, . . . . .	15.31	-	-	1:9.23	10.07	-	-	1:4.54
Dry matter, . . . . .	84.69	-	-		89.93	-	-	
	100.00	-	-		100.00	-	-	
<i>Analysis of Dry Matter.</i>								
Crude ash, . . . . .	1.72	-	-		6.99	-	-	
“ cellulose, . . . . .	2.17	48	20.83		9.21	24	44.20	
“ fat, . . . . .	4.84	85	82.28		5.31	71	75.40	
“ protein, . . . . .	12.18	79	192.44		16.72	78	260.83	
N-free extract matter, . .	79.09	98	1,550.16		61.77	77	951.26	
	100.00	-	1,845.71		100.00	-	1,331.69	

	SPRING WHEAT BRAN.				WINTER WHEAT BRAN.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Moisture, . . . . .	12.74	-	-	1:4.48	13.06	-	-	1:4.36
Dry matter, . . . . .	87.26	-	-		86.94	-	-	
	100.00	-	-		100.00	-	-	
<i>Analysis of Dry Matter.</i>								
Crude ash, . . . . .	8.06	-	-		7.76	-	-	
“ cellulose, . . . . .	13.75	24	66.00		12.74	24	61.15	
“ fat, . . . . .	5.46	71	77.53		3.43	71	48.71	
“ protein, . . . . .	16.19	78	252.56		16.24	78	253.34	
N-free extract matter, . .	56.54	77	870.72		59.83	77	921.38	
	100.00	-	1,266.81		100.00	-	1,284.58	



	CHICAGO MAIZE FEED.				BREWERS' GRAIN.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Molsture, . . . . .	9.75	-	-	1:4.49	10.19	-	-	1:3.16
Dry matter, . . . . .	90.25	-	-		89.81	-	-	
	100.00	-	-		100.00	-	-	
<i>Analysis of Dry Matter.</i>								
Crude ash, . . . . .	0.75	-	-		2.98	-	-	
" cellulose, . . . . .	9.65	62	119.66		8.07	40	64.86	
" fat, . . . . .	6.15	85	104.55		5.25	83	87.15	
" protein, . . . . .	21.88	79	337.01		22.76	74	336.85	
N-free extract matter, . . . . .	62.12	91	1,130.58		60.94	64	790.03	
	100.00	-	1,691.80		100.00	-	1,268.50	

	OLD-PROCESS LINSSEED MEAL.				NEW-PROCESS LINSSEED MEAL.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Molsture, . . . . .	8.72	-	-	1:1.63	8.29	-	-	1:1.74
Dry matter, . . . . .	91.28	-	-		91.71	-	-	
	100.00	-	-		100.00	-	-	
<i>Analysis of Dry Matter.</i>								
Crude ash, . . . . .	5.96	-	-		5.91	-	-	
" cellulose, . . . . .	8.23	26	42.79		9.43	26	40.04	
" fat, . . . . .	9.87	91	179.63		4.08	91	74.26	
" protein, . . . . .	36.19	87	629.70		35.03	87	609.51	
N-free extract matter, . . . . .	39.75	91	723.45		45.55	91	839.01	
	100.00	-	1,575.67		100.00	-	1,561.63	

	CHICAGO GLUTEN MEAL.				COTTON-SEED MEAL.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Moisture, . . . . .	11.11	-	-	1:2.66	9.77	-	-	1:1.37
Dry matter, . . . . .	88.89	-	-		90.23	-	-	
	100.00	-	-		100.00	-	-	
<i>Analysis of Dry Matter.</i>								
Crude ash, . . . . .	1.66	-	-		8.18	-	-	
" cellulose, . . . . .	0.73	62	9.06		7.74	-	-	
" fat, . . . . .	9.23	85	156.74		11.83	88	199.41	
" protein, . . . . .	83.34	79	526.77		44.41	85	754.97	
N-free extract matter, . . . . .	55.06	91	1,002.09		28.34	96	538.46	
	100.00	-	1,694.65		100.00	-	1,492.84	

	ENGLISH HAY.				ROWEN.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Moisture, . . . . .	9.72	-	-	1:9.68	13.53	-	-	1:6.93
Dry matter, . . . . .	90.28	-	-		86.47	-	-	
	100.00	-	-		100.00	-	-	
<i>Analysis of Dry Matter.</i>								
Crude ash, . . . . .	6.43	-	-		6.81	-	-	
" cellulose, . . . . .	32.28	58	374.45		28.31	58	328.40	
" fat, . . . . .	2.40	46	22.91		3.81	46	35.05	
" protein, . . . . .	9.54	57	108.76		12.94	57	147.52	
N-free extract matter, . . . . .	49.26	63	620.68		48.13	63	606.44	
	100.00	-	1,126.80		100.00	-	1,117.41	

	CORN STOVER.				CORN ENSILAGE.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Moisture, . . . . .	22.50	-	-	1:8.62	72.96	-	-	1:11.67
Dry matter, . . . . .	77.50	-	-		27.06	-	-	
	100.00	-	-		100.00	-	-	
<i>Analysis of Dry Matter.</i>								
Crude ash, . . . . .	3.97	-	-		6.48	-	-	
“ cellulose, . . . . .	34.96	72	503.42		26.33	72	379.15	
“ fat, . . . . .	1.54	75	23.10		5.17	75	77.55	
“ protein, . . . . .	9.76	73	142.50		7.64	73	111.34	
N-free extract matter, . .	40.77	67	666.92		54.38	67	728.00	
	100.00	-	1,335.94		100.00	-	1,396.93	

	MANGOLD ROOTS.				SUGAR BEETS.			
	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.	Percentage Composition.	Per Cent. of Digestibility.	Pounds Digestible in a Ton.	Nutritive Ratio.
Moisture, . . . . .	87.75	-	-	1:9.94	85.27	-	-	1:11.90
Dry matter, . . . . .	12.25	-	-		14.73	-	-	
	100.00	-	-		100.00	-	-	
<i>Analysis of Dry Matter.</i>								
Crude ash, . . . . .	9.06	-	-		5.95	-	-	
“ cellulose, . . . . .	7.94	100	158.80		6.49	100	129.80	
“ fat, . . . . .	0.88	100	17.60		0.66	100	13.20	
“ protein, . . . . .	10.37	100	207.40		10.97	100	219.40	
N-free extract matter, . .	71.75	100	1,435.00		75.93	100	1,518.00	
	100.00	-	1,818.80		100.00	-	1,881.00	

## ANALYSES OF FODDER ARTICLES SENT ON BY FARMERS.

*Corn Meal.*

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	13.52
Dry matter, . . . . .	86.48
	<hr/> 100.00

*Analysis of Dry Matter.*

Crude ash, . . . . .	2.34
“ cellulose, . . . . .	2.47
“ fat, . . . . .	4.85
“ protein (nitrogenous matter), . . . . .	15.61
Non-nitrogenous extract matter, . . . . .	74.73
	<hr/> 100.00

*Corn and Cob Meal.*

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	19.11
Dry matter, . . . . .	80.89
	<hr/> 100.00

*Analysis of Dry Matter.*

Crude ash, . . . . .	2.05
“ cellulose, . . . . .	6.97
“ fat, . . . . .	3.46
“ protein (nitrogenous matter), . . . . .	10.51
Non-nitrogenous extract matter, . . . . .	77.01
	<hr/> 100.00

Passed screen 144 meshes to square inch, . . . . . 73.88

*Hominy Chop.*

[Sent on from Southborough, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	11.32
Dry matter, . . . . .	88.68
	<hr/> 100.00

*Analysis of Dry Matter.*

Crude ash, . . . . .	2.44
“ cellulose, . . . . .	5.12
“ fat, . . . . .	11.26
“ protein (nitrogenous matter), . . . . .	6.77
Non-nitrogenous extract matter, . . . . .	74.41
	<hr/> 100.00

*Wheat Bran.*

[Sent on from Amherst, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	10.47	13.17
Dry matter, . . . . .	89.53	86.83
	100.00	100.00
<i>Analysis of Dry Matter.</i>		
Crude ash, . . . . .	7.19	7.95
“ cellulose, . . . . .	11.27	11.22
“ fat, . . . . .	4.80	4.86
“ protein (nitrogenous matter), . . . .	18.93	17.31
Non-nitrogenous extract matter, . . . .	57.81	58.66
	100.00	100.00

*I. Wheat Bran (St. Louis).**II. Spring Wheat Bran (Duluth, Minn.).*

[Sent on from Warren, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	10.12	8.97
Dry matter, . . . . .	89.88	91.03
	100.00	100.00
<i>Analysis of Dry Matter.</i>		
Crude ash, . . . . .	6.94	7.68
“ cellulose, . . . . .	9.72	10.84
“ fat, . . . . .	4.95	5.37
“ protein (nitrogenous matter), . . . .	18.08	19.54
Non-nitrogenous extract matter, . . . .	60.31	56.57
	100.00	100.00

*Ground Barley.*

[Sent on from Amherst.]

	Per Cent.
Moisture at 100° C., . . . . .	14.62
Dry matter, . . . . .	85.38
	<u>100.00</u>

*Analysis of Dry Matter.*

Crude ash, . . . . .	3.18
“ cellulose, . . . . .	5.04
“ fat, . . . . .	2.38
“ protein (nitrogenous matter), . . . . .	14.93
Non-nitrogenous extract matter, . . . . .	74.47
	<u>100.00</u>

*Gluten Meal.*

[From Amherst, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	10.90
Dry matter, . . . . .	89.10
	<u>100.00</u>

*Analysis of Dry Matter.*

Crude ash, . . . . .	1.02
“ cellulose, . . . . .	1.28
“ fat, . . . . .	7.36
“ protein (nitrogenous matter), . . . . .	34.79
Non-nitrogenous extract matter, . . . . .	65.55
	<u>100.00</u>

*Cotton-seed Meal.*

[Sent on from Amherst, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C, . . . . .	9.07	9.06
Dry matter, . . . . .	90.93	91.94
	<u>100.00</u>	<u>100.00</u>
<i>Analysis of Dry Matter.</i>		
Crude ash, . . . . .	7.50	8.11
“ cellulose, . . . . .	6.81	8.69
“ fat, . . . . .	11.17	10.71
“ protein (nitrogenous matter), . . . . .	46.38	41.26
Non-nitrogenous extract matter, . . . . .	28.14	31.28
	<u>100.00</u>	<u>100.00</u>

*Cotton-seed Meal.*

[I. sent on from Holden, Mass.; II. and III. sent on from Sunderland, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	8.90	8.50	9.37
Dry matter, . . . . .	91.10	91.50	90.63
	100.00	100.00	100.00
<i>Analysis of Dry Matter.</i>			
Crude ash, . . . . .	8.23	—	—
“ cellulose, . . . . .	7.15	—	—
“ fat, . . . . .	12.61	9.60	11.14
“ protein (nitrogenous matter), . . . . .	51.79	50.61	43.86
Non-nitrogenous extract matter, . . . . .	20.22	—	—
	100.00	—	—

*Cocoanut Meal.*

[Sent on from Concord, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	9.33
Dry matter, . . . . .	90.67
	100.00
<i>Analysis of Dry Matter.</i>	
Crude ash, . . . . .	5.68
“ cellulose, . . . . .	18.80
“ fat, . . . . .	12.88
“ protein (nitrogenous matter), . . . . .	22.61
Non-nitrogenous extract matter, . . . . .	40.03
	100.00

*Hog Feed—Bakery Refuse.*

[Sent on from North Hadley, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	13.34
Dry matter, . . . . .	86.66
	100.00
<i>Analysis of Dry Matter.</i>	
Crude ash, . . . . .	11.64
“ cellulose, . . . . .	0.43
“ fat, . . . . .	6.36
“ protein (nitrogenous matter), . . . . .	9.23
Non-nitrogenous extract matter, . . . . .	72.34
	100.00

*Hay from Salt Meadows.*

[Sent on from Newbury, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	9.66	8.08	8.75
Dry matter, . . . . .	90.34	91.92	91.25
	100.00	100.00	100.00
<i>Analysis of Dry Matter.</i>			
Crude ash, . . . . .	5.01	5.03	9.03
“ cellulose, . . . . .	27.84	27.82	31.41
“ fat, . . . . .	2.65	3.24	3.37
“ protein (nitrogenous matter), . . . . .	4.35	3.77	6.72
Non-nitrogenous extract matter, . . . . .	60.15	60.14	49.47
	100.00	100.00	100.00

*Methods of Analysis of Cattle Foods.*

1. *Moisture.*—Dry 2 grams in an air-bath at 100–110° C. to a constant weight.

2. *Ash.*—Char 2 to 5 grams in a muffle furnace at a low red heat, cool and weigh. Digest for a short time with dilute hydrochloric acid; collect the residue insoluble in acid in a Gooch crucible, wash, dry and weigh. Subtract this from the total weight for pure ash.

3. *Ether Extract.*—Dry 2 grams at 100° C. for two hours. Exhaust with anhydrous, alcohol-free ether, until the extraction is complete. Dry the extract in the air-bath at 100° C. to a constant weight.

4. *Crude Protein.*—Determine nitrogen by the Kjeldahl or soda-lime method, and multiply the result by 6.25 for crude protein.

5. *Albuminoid Nitrogen.*—Determine by Stutzer's method, as given in the “Proceedings of the Association of Official Agricultural Chemists,” 1890 (pages 211 and 212), except that the protein-copper is dried before being introduced into the flask.

6. *Crude Fibre or Cellulose.*—The method is described in the “Proceedings of the Association of Official Agricultural Chemists,” 1890 (page 212). In this method 2 grams of



the material, having been nearly or completely freed from fat, are boiled for thirty minutes with 200 cubic centimetres of  $1\frac{1}{4}$  per cent. sulphuric acid, brought upon a linen filter and thoroughly washed with boiling water. It is then washed into the boiling-flask with a  $1\frac{1}{4}$  per cent. solution of sodium hydrate, brought quickly to  $100^{\circ}$  C., and boiled for thirty minutes, when it is filtered through a Gooch crucible, or balanced filter-papers, washed with boiling water, alcohol and ether, dried at  $100^{\circ}$  C. for an hour, and weighed. The organic matter is then burned off, and the weight of the ash deducted for crude cellulose.

## II.

FEEDING EXPERIMENTS WITH STEERS.

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The question of a remunerative production of beef for the meat market, upon the farms of New England, has, for several years past, received a deserved attention at the Massachusetts State Agricultural Experiment Station, by carrying on feeding experiments, under well-defined circumstances, with growing steers. The results of observations in that direction during two preceding years are ready for publication. The work is to be continued with such modifications as suggest themselves during its progress, and the conclusions arrived at will be published hereafter, whenever they are found to be of a more general interest to the farming community.

The first experiment, December, 1889, to May, 1890, briefly described upon a few succeeding pages, was planned mainly with a view to determine *the cost of the feed* required for the production of beef for the meat market under existing local conditions, and with special reference to the contemporary local market price of the fodder articles at our disposal.

Current home-raised fodder articles, as fodder corn, corn stover, corn ensilage and sugar beets, served as coarse feed, while corn and cob meal, wheat bran, old-process linseed meal and gluten meal furnished the grain feed for daily diet of the animals on trial. The stated amount of grain feed was in each case a fixed quantity, while the consumption of coarse feed was governed by the appetite of the animal.

One and two year old grade Shorthorn steers, two of each kind, were chosen for the observation. The steers selected were, as far as possible, of a similar general character with reference to breed. They were chosen of a different age to offer a desirable chance to determine *the difference in the cost of the feed* for the production of a corresponding increase in the live weight of both one and two year old animals.

The same kinds of fodder articles served at the same stage of the experiment for all animals engaged in the experiment alike in the compounding of their daily diet; they were, however, given in different proportion and in different quantities to animals of different ages. The daily diet of one and two year old steers was compounded with a due consideration of the wants at the particular age of each lot. Their respective daily diet consequently differed essentially only in regard to quantity and proportion of the same fodder articles.

The local market price of the various fodder articles used at the time of the observation has been adopted as the basis of determining the cost of the daily fodder rations. A loss of eight per cent. of the essential fertilizing constituents contained in the food consumed has been assumed a fair compensation for the amount of nitrogen, phosphoric acid and potassium oxide retained in the growing animal, and thereby lost to the manurial resources of the farm. Accepting E. Wolff's statement of the chemical composition of a live steer as the basis in our calculation of the loss of the above-stated manurial substances, one hundred pounds of increase in the live weight of the steers, at the present market value of phosphoric acid, potassium oxide and nitrogen, represents a loss of from 52 to 55 cents to the manurial resources of the farm. From the previous statement, it will be noticed that ninety-two per cent. of the essential fertilizing constituents contained in the feed consumed are considered available in the manure produced in connection with raising steers for the meat market. The *net cost* of the feed stated in the subsequent report of our financial results represents, therefore, the cost of the feed consumed, after deducting from its original market price ninety-two per

cent. of the money value of the essential fertilizing constituents, *i. e.*, nitrogen, phosphoric acid and potassium oxide, it contains.

The statements of the relative proportion of the digestible nitrogenous and non-nitrogenous food constituents of the daily diet (its nutritive ratio) are based on the mean of more recent observations in connection with actual feeding experiments elsewhere (Wolff).

The different daily fodder rations recorded below were compounded with a view to compare different combinations of well-known feed stuffs with reference to feeding effect and to influence on cost of feed. Those daily fodder rations which have given us the most satisfactory results in this connection may be seen below (rations I. and II.).

The general history of the management of the experiment and the financial results of the whole operation are published upon a few subsequent pages. It is for obvious reasons not advisable to enter at this early stage of our experiments upon a detailed critical discussion of the lessons which may be learned from the results obtained. Some facts, however, brought out in the course of the experiment, are apparently so well supported under existing circumstances that a brief statement concerning them may claim some special attention.

### *Results.*

1. Corn ensilage, when fed either with wheat bran and gluten meal, or with wheat bran and old-process linseed meal, has produced in our case, without an exception, the highest gain in live weight, as compared with other fodder rations used in the experiment (see fodder rations I., II., below).

2. The increase in live weight per day, when feeding the ensilage fodder rations (I., II.) to one-year old steers, has in one instance (steer 2) exceeded three pounds, while in the case of two-year old steers it has averaged more than four pounds per day in one case (steer 4).

3. The original cost of the feed (corn ensilage, fodder rations I., II.) consumed per day has been from 12.82 cents to 14.72 cents in case of one-year old steers (1, 2),

and from 16.67 cents to 19.33 cents in case of two-year old steers (3, 4).

4. The net cost of the feed (corn ensilage, fodder rations I., II.) consumed per day has been from 4.81 cents to 5.26 cents in the case of one-year old steers (1, 2), and from 6.65 cents to 7.44 cents in case of two-year old steers.

5. The daily increase in the live weight of the one-year old steers during both periods of feeding ensilage fodder rations (I., II.) averages 2.9 pounds. The original market cost of that diet averages, per day, 13.29 cents, hence the original cost of the feed consumed per pound of live weight gained amounts to 4.8 cents, while the net cost of the feed consumed per pound of live weight gained amounts to 1.82 cents.

6. The daily increase in the live weight of the two-year old steers during both periods of feeding ensilage fodder rations (I., II.) averages 3.45 pounds. The original market cost of that daily diet averages for both periods, per day, 18 cents, hence the original market cost of the feed consumed for every pound of live weight produced amounts to 5.22 cents, while the net cost of the feed consumed per pound of live weight gained amounts to 2.08 cents.

7. The difference in the financial result presented above and of the subsequent financial summaries of the entire feeding experiment is due to the less profitable daily fodder ration used during the experiment in connection with the ensilage fodder rations (I., II.).

*Local Market Value per Ton of the Various Articles of Fodder used, 1889-90.*

[illegible]

*Valuation of Essential Fertilizing Constituents in the Various  
Articles of Fodder used.*

	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Corn and Cob Meal.	Corn Stover.	Corn Ensilage.	Corn Fodder.	Sugar Beets.
Moisture, . . . .	9.27	9.80	9.88	8.10	26.95	72.95	20.42	90.02
Nitrogen, . . . .	2.545	4.510	5.331	1.439	.923	.330	1.058	.184
Phosphoric acid, . .	2.900	.392	1.646	.603	.303	1.138	.510	.086
Potassium oxide, . .	1.637	.049	1.162	.441	1.320	.301	.700	.462
Valuation per 2,000 lbs.,	\$13 60	\$16 18	\$21 15	\$5 02	\$4 69	\$1 55	\$4 89	\$1 14

*Daily Fodder Rations used.*

I.

Wheat bran, . . . . .	3.88 lbs.
Gluten meal, . . . . .	3.88 "
Corn ensilage, . . . . .	37.50 "
Nutritive ratio, . . . . .	1:5.49
Total cost, . . . . .	12.82 cts.
Manurial value obtainable, . . . . .	8.01 "
Net cost, . . . . .	4.81 "

II.

Wheat bran, . . . . .	4.00 lbs.
Old-process linseed meal, . . . . .	4.00 "
Corn ensilage, . . . . .	43.38 "
Nutritive ratio, . . . . .	1:5.69
Total cost, . . . . .	14.76 cts.
Manurial value obtainable, . . . . .	9.50 "
Net cost, . . . . .	5.26 "

III.

Wheat bran, . . . . .	3.00 lbs.
Old-process linseed meal, . . . . .	3.00 "
Corn and cob meal, . . . . .	3.00 "
Corn fodder, . . . . .	9.00 "
Nutritive ratio, . . . . .	1:4.93
Total cost, . . . . .	12.45 cts.
Manurial value obtainable, . . . . .	7.65 "
Net cost, . . . . .	4.80 "

*Daily Fodder Rations used — Concluded.*

## IV.

Wheat bran, . . . . .	3.00 lbs.
Old-process linseed meal, . . . . .	3.00 "
Corn and cob meal, . . . . .	3.00 "
Corn stover, . . . . .	6.00 "
Nutritive ratio, . . . . .	1 : 4.55
Total cost, . . . . .	10.58 cts.
Manurial value obtainable, . . . . .	6.92 "
Net cost, . . . . .	3.66 "

## V.

Wheat bran, . . . . .	3.00 lbs.
Old-process linseed meal, . . . . .	3.00 "
Corn and cob meal, . . . . .	3.00 "
Corn stover, . . . . .	3.60 "
Sugar beets, . . . . .	20.00 "
Nutritive ratio, . . . . .	1 : 4.49
Total cost, . . . . .	14.98 cts.
Manurial value obtainable, . . . . .	7.44 "
Net cost, . . . . .	7.54 "

## VI.

Wheat bran, . . . . .	2.25 lbs.
Gluten meal, . . . . .	2.25 "
Corn stover, . . . . .	12.00 "
Nutritive ratio, . . . . .	1 : 5.51
Total cost, . . . . .	7.45 cts.
Manurial value obtainable, . . . . .	5.68 "
Net cost, . . . . .	1.77 "

*Steer 1 (Yearling).*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.								Total Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Corn and Cob Meal.	Corn Stover.	Corn ensilage.	Corn Fodder.	Sugar Beets.					
<b>1890-91.</b>													
Dec. 17 to Dec. 31, . . .	2.27	2.33	-	-	5.27	-	-	-	7.82	1:4.63	675	654	-1.40
Jan. 4 to Jan. 22, . . .	3.88	3.88	-	-	-	37.89	-	-	16.72	1:5.51	667	708	2.16
Jan. 28 to Feb. 16, . . .	4.00	-	4.00	-	-	42.20	-	-	19.90	1:5.63	725	783	2.90
Feb. 21 to March 11, . . .	3.00	-	3.00	3.00	-	-	9.42	-	15.68	1:4.98	785	820	1.84
March 14 to April 21, . . .	3.00	-	3.00	3.00	5.91	-	-	-	12.50	1:4.54	828	880	1.33
April 24 to May 9, . . .	3.00	-	3.00	3.00	3.50	-	-	20.00	12.74	1:4.47	882	895	0.81



# 114 AGRICULTURAL EXPERIMENT STATION. [Jan.

*Total Amount of Feed consumed from Dec. 17, 1889, to May 9, 1890.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
465.50 pounds wheat bran, . . .	422.35	\$3 84	\$3 17
95.50 pounds gluten meal, . . .	86.14	1 10	0 77
371.00 pounds old-process linseed meal,	334.35	5 10	3 92
239.00 pounds corn and cob meal, .	219.64	1 97	0 72
243.50 pounds corn stover, . . .	177.88	0 61	0 57
1,927.00 pounds corn ensilage, . .	521.25	2 65	1 50
205.50 pounds corn fodder, . . .	163.54	0 77	0 50
350.00 pounds sugar beets, . . .	34.93	0 88	0 20
	1,960.08	\$16 92	\$11 35

	Pounds.
Live weight of animal at beginning of experiment, . . .	675.00
Live weight of animal at end of feeding, . . .	895.00
Live weight gained during experiment, . . .	220.00
Average gain in weight per day, . . .	1.53
Dry matter consumed per pound of live weight gained, . .	8.91
Cost of feed per pound of live weight gained, . . .	7.69 cents.
Net cost of feed per pound of live weight gained, allowing	
8 per cent. loss of manurial value, . . .	2.95 cents.

## Steer 2 (Yearling).

FEEDING PERIODS	FEED CONSUMED (POUNDS) PER DAY.								Total Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Corn and Cob Meal.	Corn Stover.	Corn Kaffee.	Corn Fodder.	Sugar Beets.					
1891-92.													
Dec. 17 to Dec. 31, . . . . .	2.00	2.07	-	-	5.27	-	-	-	6.53	1:4.76	600	590	-0.67
Jan. 4 to Jan. 22, . . . . .	3.88	3.88	-	-	-	37.92	-	-	16.54	1:5.47	610	674	8.97
Jan. 28 to Feb. 16, . . . . .	4.00	-	4.00	-	-	44.55	-	-	19.97	1:5.75	680	745	3.25
Feb. 21 to March 11, . . . . .	3.00	-	3.00	3.00	-	-	8.53	-	14.97	1:4.87	746	770	1.26
March 14 to April 21, . . . . .	3.00	-	3.00	3.00	6.00	-	-	-	12.56	1:4.55	776	826	1.28
April 24 to May 9, . . . . .	3.00	-	3.00	3.00	3.69	-	-	20.00	12.88	1:4.50	828	840	0.75

# 116 AGRICULTURAL EXPERIMENT STATION. [Jan.

*Total Amount of Feed consumed from Dec. 17, 1889, to May 9, 1890.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
465.50 pounds wheat bran, . . .	422.35	\$3 84	\$3 17
95.50 pounds gluten meal, . . .	86.14	1 10	0 77
371.00 pounds old-process linseed meal;	334.35	5 10	3 92
239.00 pounds corn and cob meal, .	219.64	1 97	0 72
354.00 pounds corn stover, . . .	258.60	0 89	0 83
1,942.00 pounds corn ensilage, . .	525.31	2 67	1 51
285.00 pounds corn fodder, . . .	226.80	1 07	0 70
350.00 pounds sugar beets, . . .	34.93	0 88	0 20
	2,108.12	\$17 52	\$11 82

	Pounds.
Live weight of animal at beginning of experiment, . . .	600.00
Live weight of animal at end of feeding, . . .	840.00
Live weight gained during experiment, . . .	240.00
Average gain in weight per day, . . .	1.67
Dry matter consumed per pound of live weight gained, . .	8.78
Cost of feed per pound of live weight gained, . . .	7.90 cents.
Net cost of feed per pound of live weight gained, allow- ing 8 per cent. loss of manurial value, . . .	2.77 cents.

*Summary of Feeding Experiment with Steers One Year Old.*

	No. 1.	No. 2.
Beginning of feeding experiment, . . . . .	Dec. 17, 1889.	Dec. 17, 1889.
Close of feeding experiment, . . . . .	May 9, 1890.	May 9, 1890.
Number of days of observation, . . . . .	144	144
Live weight of animals at the beginning of observation, .	675 lbs.	600 lbs.
Live weight of animals at the close of observation, . .	895 "	840 "
Total number of pounds of live weight gained during the experiment, : . . . . .	220 "	240 "
Average gain in live weight per day, . . . . .	1.53 "	1.67 "
Amount of dry vegetable matter consumed per pound of live weight gained, . . . . .	8.91 "	8.78 "
Total cost of feed consumed per day, . . . . .	11.75 cts.	12.16 cts.
Manurial value of feed consumed per day, . . . . .	7.87 "	8.20 "
Manurial value of feed consumed, allowing 8 per cent. loss, .	7.24 "	7.54 "
Net cost of feed consumed per day, allowing a loss of 8 per cent. of manurial value for live weight gained, . . . .	4.51 "	4.62 "
Net cost of feed per pound of live weight gained, . . .	2.95 "	2.77 "

*Summary of Record of Steers No. 1 and No. 2, when left in the Pasture, May 10, 1889, to Sept. 30, 1889.*

	No. 1.	No. 2.
Date of turning steers into pasture, . . . . .	May 10, 1889.	May 10, 1889.
Date of closing pasturing, . . . . .	Sept. 30, 1889.	Sept. 30, 1889.
Number of days of pasturing, . . . . .	144	144
Live weight of steers when turned into pasture, . . . .	895 lbs.	840 lbs.
Live weight of steers at the close of pasturing, . . . .	1,020 "	923 "
Total weight gained during pasturing, . . . . .	125 "	83 "
Average gain in weight per day, . . . . .	0.87 "	0.58 "
Cost of feed per day, allowing 40 cents per week for use of pasture, . . . . .	5.71 cts.	5.71 cts.
Cost of feed per pound of live weight gained, . . . .	6.58 "	9.91 "

*Two-year Old Grade Shorthorn Steers.*

[The same fodder articles as in the case of the one-year old steers served here.]

*Daily Fodder Rations Used.*

## I.

Wheat bran, . . . . .	3.88 lbs.
Gluten meal, . . . . .	3.88 "
Corn ensilage, . . . . .	65.50 "
Nutritive ratio, . . . . .	1 : 6.54
Total cost, . . . . .	16.67 cts.
Manurial value obtainable, . . . . .	10.02 "
Net cost, . . . . .	6.65 "

## II.

Wheat bran, . . . . .	4.00 lbs.
Old-process linseed meal, . . . . .	4.00 "
Corn ensilage, . . . . .	76.60 "
Nutritive ratio, . . . . .	1 : 6.75
Total cost, . . . . .	19.33 cts.
Manurial value obtainable, . . . . .	11.89 "
Net cost, . . . . .	7.44 "

## III.

Wheat bran, . . . . .	4.00 lbs.
Old-process linseed meal, . . . . .	4.00 "
Corn and cob meal, . . . . .	4.00 "
Corn fodder, . . . . .	12.35 "
Nutritive ratio, . . . . .	1 : 4.91
Total cost, . . . . .	16.73 cts.
Manurial value obtainable, . . . . .	10.28 "
Net cost, . . . . .	6.45 "

## IV.

Wheat bran, . . . . .	4.00 lbs.
Old-process linseed meal, . . . . .	4.00 "
Corn and cob meal, . . . . .	4.00 "
Corn stover, . . . . .	13.00 "
Nutritive ratio, . . . . .	1 : 4.99
Total cost, . . . . .	15.35 cts.
Manurial value obtainable, . . . . .	10.30 "
Net cost, . . . . .	5.05 "

## V.

Wheat bran, . . . . .	2.65 lbs.
Gluten meal, . . . . .	2.65 "
Corn stover, . . . . .	18.00 "
Nutritive ratio, . . . . .	1 : 5.84
Total cost, . . . . .	9.74 cts.
Manurial value obtainable, . . . . .	7.51 "
Net cost, . . . . .	2.23 "

## Steer No. 3.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.							Total Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Corn and Cob Meal.	Corn Stover.	Corn ensilage.	Corn Fodder.					
1899-99.												
Dec. 10 to Dec. 31, . . . . .	2.64	2.68	-	-	9.00	-	-	11.89	1: 5.15	1,235	1,192	-1.95
Jan. 4 to Jan. 22, . . . . .	3.88	3.88	-	-	-	68.95	-	24.60	1: 6.64	1,210	1,297	4.58
Jan. 28 to Feb. 16, . . . . .	4.00	4.00	-	-	-	80.10	-	90.13	1: 6.89	1,310	1,362	2.60
Feb. 21 to March 11, . . . . .	4.00	-	4.00	4.00	-	-	14.00	22.05	1: 5.11	1,362	1,366	0.21
March 13 to March 25, . . . . .	4.00	-	4.00	4.00	14.67	-	-	21.63	1: 5.09	1,367	1,370	0.23

# 120 AGRICULTURAL EXPERIMENT STATION. [Jan.

*Total Amount of Feed consumed from Dec. 10, 1889, to  
March 25, 1890.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
387.50 pounds wheat bran, . . .	351.58	\$3 20	\$2 64
140.50 pounds gluten meal, . . .	126.73	1 62	1 14
248.00 pounds old-process linseed meal,	223.50	3 41	2 62
135.00 pounds corn and cob meal, .	124.07	1 11	0 41
392.00 pounds corn stover, . . .	286.36	0 98	0 92
3,542.00 pounds corn ensilage, . .	958.11	4 87	2 76
315.00 pounds corn fodder, . . .	250.68	1 18	0 77
	2,321.03	\$16 37	\$11 26

	Pounds.
Live weight of animal at beginning of experiment, . . .	1,235.00
Live weight at time of killing, . . . . .	1,370.00
Live weight gained during experiment, . . . . .	135.00
Average gain in weight per day, . . . . .	1.27
Dressed weight of animal, . . . . .	886.00
Loss in weight by dressing, . . . . . 484 pounds, or 35.33 per cent.	
Original cost of animal, 1,336 pounds, at 3½ cents, . . . .	\$46 76
Selling price of animal, 886 pounds, at 6 cents, . . . .	53 16
Net cost of feed after deducting 8 per cent. of manurial value, . . .	6 01
Dry matter required to produce 1 pound of live weight, . .	17.19 pounds.
Cost of feed per pound gained, . . . . .	12.13 cents.
Net cost of feed per pound gained after deducting 8 per cent of manurial value, . . . . .	4.45 cents

## Steer No. 4.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.							Total Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Corn and Cob Meal.	Corn Stover.	Corn Ensilage.	Corn Pudder.					
1899-90.												
Dec. 10 to Dec. 31,	2.64	2.68	-	-	5.25	-	-	8.65	1:4.45	1,180	1,138	-1.91
Jan. 4 to Jan. 22,	3.88	3.88	-	-	-	62.21	-	20.92	1:6.43	1,162	1,250	4.63
Jan. 28 to Feb. 16,	4.00	4.00	-	-	-	73.10	-	28.13	1:6.70	1,246	1,317	3.55
Feb. 21 to March 11,	4.00	-	4.00	4.00	-	-	10.71	19.43	1:4.81	1,305	1,293	-0.63
March 13 to March 25,	4.00	-	4.00	4.00	11.25	-	-	19.63	1:4.89	1,297	1,300	0.23



# 122 AGRICULTURAL EXPERIMENT STATION. [Jan.

*Total Amount of Feed consumed from Dec. 10, 1889, to  
March 25, 1890.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
387.50 pounds wheat bran, . . .	351.58	\$3 20	\$2 64
140.50 pounds gluten meal, . . .	126.73	1 62	1 14
248.00 pounds old-process linseed meal,	223.50	3 41	2 62
135.00 pounds corn and cob meal, .	124.07	1 11	0 41
267.00 pounds corn stover, . . .	195.04	0 67	0 63
3,210.50 pounds corn ensilage, . .	868.44	4 41	2 50
238.00 pounds corn fodder, . . .	189.40	0 89	0 46
	2,078.76	\$15 31	\$10 40

	Pounds.
Live weight of animal at beginning of experiment, . . .	1,180.00
Live weight at time of killing, . . . . .	1,300.00
Live weight gained during experiment, . . . . .	120.00
Average gain in weight per day, . . . . .	1.13
Dressed weight of animal, . . . . .	859.00
Loss in weight by dressing, . . . . . 441 pounds, or 33.92 per cent.	
Original cost of animal, 1,332 pounds, at 3½ cents, . . .	\$46 62
Selling price of steer, 859 pounds, at 6 cents, . . . . .	51 54
Net cost of feed after deducting 8 per cent. of manurial value, .	5 74
Dry matter required to produce 1 pound of live weight, .	17.32 pounds.
Cost of feed per pound gained, . . . . .	12.76 cents.
Net cost of feed per pound gained, after deducting 8 per cent. of manurial value, . . . . .	4.78 cents.

*Summary of Feeding Experiments, Steers Two Years Old, Nos. 3 and 4.*

	No. 3.	No. 4.
Beginning of feeding experiment, . . . . .	Dec. 10, 1889.	Dec. 10, 1889.
Close of observation, . . . . .	Mar. 25, 1890.	Mar. 25, 1890.
Number of days of observation, . . . . .	106	106
Live weight of animals at the beginning of observation, . . . . .	1,235 lbs.	1,180 lbs.
Live weight of animals at close of observation, . . . . .	1,370 "	1,300 "
Total number of pounds of live weight gained during experiment, . . . . .	135 "	120 "
Average gain in live weight per day, . . . . .	1.27 "	1.13 "
Amount of dry vegetable matter consumed per pound of live weight gained, . . . . .	17.19 "	17.32 "
Total cost of feed consumed per day, . . . . .	15.44 cts.	14.44 cts.
Manurial value of feed consumed per day, . . . . .	10.62 "	9.82 "
Manurial value of feed consumed per day, allowing 8 per cent. loss, . . . . .	9.77 "	9.03 "
Net cost of feed consumed per day, allowing a loss of 8 per cent. of manurial value, . . . . .	5.67 "	5.41 "
Net cost of feed consumed per pound of live weight gained, . . . . .	4.45 "	4.78 "
Selling price of dressed weight, . . . . .	6.00 "	6.00 "
Per cent. of shrinkage in dressing beef for the market, . . . . .	35.3	33.9

*Analyses of Fodder Articles used in the Experiment.**Corn and Cob Meal.*

1889-90.

Moisture at 100° C., . . . . .	Per Cent 8.10
Dry matter, . . . . .	91.90
	100.00

*Analysis of Dry Matter.*

Crude ash, . . . . .	1.47
" cellulose, . . . . .	5.63
" fat, . . . . .	3.73
" protein (nitrogenous matter), . . . . .	9.79
Non-nitrogenous extract matter, . . . . .	79.38
	100.00
Passed screen, 144 meshes to square inch, . . . . .	76.34

*Wheat Bran (Average).*

1898-1899.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	9.27	185.40	-	-	1:3.94
Dry matter, . . . . .	90.73	1,814.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	7.47	149.40	-	-	
“ cellulose, . . . . .	9.75	195.00	39.00	20	
“ fat, . . . . .	5.48	109.60	87.68	80	
“ protein (nitrogenous matter), . . . . .	17.53	350.60	308.53	88	
Non-nitrogenous extract matter, . . . . .	59.77	1,195.40	956.32	80	
	100.00	2,000.00	1,391.53	-	

*Gluten Meal.*

1898-1899.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	9.80	196.00	-	-	1:2.60
Dry matter, . . . . .	90.20	1,804.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.25	25.00	-	-	
“ cellulose, . . . . .	1.75	35.00	11.90	34	
“ fat, . . . . .	7.00	140.00	106.40	76	
“ protein (nitrogenous matter), . . . . .	31.25	625.00	531.25	85	
Non-nitrogenous extract matter, . . . . .	58.75	1,175.00	1,104.50	94	
	100.00	2,000.00	1,754.05	-	

*Old-process Linseed Meal (Average).*

1888-1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	9.88	197.60	—	—	1:1.70
Dry matter, . . . . .	90.12	1,802.40	—	—	
	160.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	7.39	147.80	—	—	
“ cellulose, . . . . .	8.74	174.80	45.45	26	
“ fat, . . . . .	7.24	144.80	131.77	91	
“ protein (nitrogenous matter), . . . . .	36.97	739.40	643.28	87	
Non-nitrogenous extract matter, . . . . .	39.66	793.20	721.81	91	
	100.00	2,000.00	1,542.31	—	

*Sugar Beets.*

1888-1890.

	Percentage Composition.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digestible in a Ton of 2,000 Pounds.	Per Cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	90.02	1,800.40	—	—	1:6.74
Dry matter, . . . . .	9.98	199.60	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	11.84	236.80	—	—	
“ cellulose, . . . . .	8.20	164.00	164.00	100	
“ fat, . . . . .	.71	14.20	14.20	100	
“ protein (nitrogenous matter), . . . . .	11.53	230.60	230.60	100	
Non-nitrogenous extract matter, . . . . .	67.72	1,354.40	1,354.40	100	
	100.00	2,000.00	1,763.20	—	

*Corn Ensilage (Average).*

1888-1890.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	72.95	1,459.00	-	-	1:11.67
Dry matter, . . . . .	27.05	541.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.48	129.60	-	-	
" cellulose, . . . . .	26.83	526.60	379.15	72	
" fat, . . . . .	5.17	103.40	77.55	75	
" protein (nitrogenous matter), . . . . .	7.64	152.80	111.54	73	
Non-nitrogenous extract matter, . . . . .	54.38	1,087.60	728.69	67	
	100.00	2,000.00	1,296.93	-	

*Corn Fodder.*

1888-1890.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	20.42	408.40	-	-	1:9.80
Dry matter, . . . . .	79.58	1,591.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	7.40	148.00	-	-	
" cellulose, . . . . .	20.11	402.20	289.58	72	
" fat, . . . . .	1.65	33.00	24.75	75	
" protein (nitrogenous matter), . . . . .	8.31	166.20	121.33	73	
Non-nitrogenous extract matter, . . . . .	62.53	1,250.60	837.90	67	
	100.00	2,000.00	1,273.56	-	

*Corn Stover.*

[From Amherst, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	19.89
Dry matter, . . . . .	80.11

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100.00*Analysis of Dry Matter.*

Crude ash, . . . . .	6.33
“ cellulose, . . . . .	34.59
“ fat, . . . . .	1.28
“ protein (nitrogenous matter), . . . . .	5.74
Non-nitrogenous extract matter, . . . . .	52.06

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100.00

## III.

## FEEDING EXPERIMENTS WITH LAMBS.

SEPTEMBER 30, 1890, TO APRIL 20, 1891.

The feeding experiment with lambs described below is the second of a series devised to ascertain the influence of different fodder rations on the cost of feed when fattening lambs during the winter for the meat market.

The selection of animals was made from the temporary supply of our local market. Six lambs, wethers, grades of uncertain parentage, served for the trial; they were shorn before being weighed at the beginning of the observation. Each animal occupied a separate pen during the entire experiment. They received during the first week the same daily diet, and were subsequently divided into two lots of three each (lots A and B), to test the effect of different grain feed rations on the ultimate financial results of the operation.

*1. Weight of Lambs.*

	Original Live Weight of Lambs (Pounds).	Weight of Wool removed (Pounds).	Live Weight at the Beginning (Pounds).
Lot A. { 1, . . . . 2, . . . . 3, . . . .	50.25	2.75	47.50
	64.00	3.50	60.50
	62.50	4.50	58.00
	176.75	10.75	166.00
Lot B. { 4, . . . . 5, . . . . 6, . . . .	52.25	2.75	49.50
	63.75	1.75	62.00
	52.00	1.50	50.50
	168.00	6.00	162.00

## 2. *Cost of Lambs.*

The entire lot was bought at 5 cents per pound of live weight, and the sum paid for the entire original live weight of 344.75 pounds amounted to \$17.24.

The wool subsequently secured before the beginning of the feeding experiment was sold at 25 cents per pound, or \$4.19 for 16.75 pounds of wool.

Deducting the sum of \$4.19 obtained for the wool removed from the first cost of the lambs, which was \$17.24, it will be noticed that their actual cost was but \$13.05, or 3.98 cents per pound of live weight. Their live weight after the removal of the wool amounted to 328 pounds.

Lot A.	1.	47.50 pounds, at 3.98 cents,	.	.	.	\$1 89	} \$6 61
	2.	60.50 pounds, at 3.98 cents,	.	.	.	2 41	
	3.	58.00 pounds, at 3.98 cents,	.	.	.	2 31	
Lot B.	4.	49.50 pounds, at 3.98 cents,	.	.	.	\$1 97	} \$6 44
	5.	62.00 pounds, at 3.98 cents,	.	.	.	2 46	
	6.	50.50 pounds, at 3.98 cents,	.	.	.	2 01	

## 3. *Character and Cost of Fodder Articles used.*

The grain feed rations of the daily diet contained, at different times and in varying proportions, corn meal, wheat bran, old-process linseed meal and Chicago gluten meal; while rowen—hay of second cut of upland meadows—and corn ensilage furnished its coarse feed constituent. The corn ensilage was produced from a dent corn variety, Pride of the North, which was cut when the kernels began to glaze.

The grain feed stuffs were bought in our local market; they were fair articles of their kind. Their relative composition and general economical value will be seen from the subsequent statements.



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ANALYSES OF FODDER ARTICLES USED.	Corn Meal.	Wheat Bran.	Old-process Lin- seed Meal.	Gluten Meal.	Rowen.	Corn Ensilage.
Moisture at 100° C., . . .	13.26	12.11	8.72	10.90	13.90	80.53
Dry matter, . . . . .	86.74	87.89	91.29	89.10	86.10	19.47
	100.00	100.00	100.00	100.00	100.00	100.00
<i>Analysis of Dry Matter.</i>						
Crude ash, . . . . .	1.72	7.40	5.96	1.02	8.28	6.73
“ cellulose, . . . . .	2.28	12.17	8.23	1.28	28.88	26.90
“ fat, . . . . .	4.90	5.04	9.87	7.36	3.91	3.27
“ protein (nitroge- nous matter), . . . . .	12.94	18.48	36.19	34.79	13.45	8.97
Non-nitrogenous extract matter, . . . . .	78.16	56.91	39.75	55.55	45.48	54.13
	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing constituents of the above fodder articles: Nitrogen, 15 cents; phosphoric acid, 5½ cents; potassium oxide, 4¼ cents per pound.

Moisture, . . . . .	13.26	12.11	8.72	10.90	13.90	80.53
Nitrogen, . . . . .	1.796	2.599	5.285	4.959	1.853	.279
Phosphoric acid, . . . . .	.707	2.845	1.780	.425	.464	.101
Potassium oxide, . . . . .	.435	1.625	1.214	.045	1.966	.226
Valuation per 2,000 pounds, . . . . .	\$6 56	\$12 39	\$18 90	\$15 38	\$7 84	\$1 15

## Local Market Value per Ton of the Various Articles of Fodder used (1890-1891).

Corn meal, . . . . .	\$28 00
Wheat bran, . . . . .	25 00
Old-process linseed meal, . . . . .	26 00
Gluten meal, . . . . .	28 00
Rowen, . . . . .	15 00
Corn ensilage, . . . . .	2 75

#### 4. *Mode of Feeding.*

The time occupied by the experiment amounted to two hundred and two days; it was divided into four feeding periods. The first feeding period extended over fourteen days, the second lasted ninety-eight days, the third thirty-four days and the fourth forty-one days. Eight days were usually allowed to pass by between succeeding feeding periods before the results accompanying the changes made in the diet were recorded. Each animal was kept in a separate pen; all received during the first period the same daily diet. This course was adopted to give each a fair chance in feed, and to bring all animals as far as practicable into a desirable uniform condition for a subsequent comparative test regarding the merits and good economy of different grain feed rations for meat production. They received their feed twice a day. At the close of the first feeding period a division of the lambs into two lots, A and B, each numbering three, was made for the purpose of *testing different grain feed rations in connection with the same article of coarse feed.*

The daily grain feed ration during *the first feeding period* consisted of a mixture of two weight parts of wheat bran and one weight part of old-process linseed meal. Eight ounces of this mixture were fed, per head, for every pound of rowen consumed. The amount of the grain feed mixture consumed daily per head varied from twelve to fourteen ounces, and that of rowen from one and one-half pounds to one and three-quarters pounds in case of different animals. *Subsequently two different combinations of grain feed were fed to the two lots of lambs (A and B).*

The daily grain feed ration in case of Lot A (1, 2 and 3) consisted of a mixture of ten weight parts of corn meal, two weight parts of wheat bran and one weight part of Chicago gluten meal. Lot B (4, 5 and 6) received as daily grain feed ration, during the same time, a mixture of two weight parts of wheat bran and one weight part of Chicago gluten meal.

Rowen and rowen with corn ensilage furnished alternately for both lots at corresponding periods the coarse feed portion of their daily diet. *Both lots of lambs received as their daily diet eight ounces of their respective grain feed mixture*

in connection with *one pound of rowen* or *one-third of one pound of rowen*, with all the corn ensilage they would consume ( $2\frac{1}{4}$  to 3 pounds). The daily diet of both lots differed essentially in regard to the relative proportion of digestible nitrogenous and non-nitrogenous food constituents they contained.

The fodder rations fed to lambs 1, 2, 3 were *less rich* in nitrogenous constituents (1: 6.50 to 1: 7.40) than those fed to lambs 4, 5, 6 (1: 4.50 to 1: 5.00). The subsequent statement contains the average composition of the daily fodder ration (per head) during the succeeding periods. Twenty per cent. of the phosphoric acid, potassium oxide and nitrogen contained in the feed consumed has been allowed as stored up in the increased live weight of the animal, and otherwise lost to the manurial refuse.

*Average Daily Fodder Rations used for Lambs Nos. 1, 2 and 3.*

I.	
Wheat bran, . . . . .	0.50 lbs.
Old-process linseed meal, . . . . .	0.25 "
Rowen, . . . . .	1.40 "
Nutritive ratio, . . . . .	1: 4.32
Total cost, . . . . .	2.00 cts.
Net cost, . . . . .	0.99 "
Manurial value obtainable, . . . . .	1.01 "
II.	
Corn meal, . . . . .	0.60 lbs.
Wheat bran, . . . . .	0.12 "
Gluten meal, . . . . .	0.06 "
Rowen, . . . . .	1.35 "
Nutritive ratio, . . . . .	1: 6.51
Total cost, . . . . .	2.08 cts.
Net cost, . . . . .	1.30 "
Manurial value obtainable, . . . . .	0.78 "
III.	
Corn meal, . . . . .	0.60 lbs.
Wheat bran, . . . . .	0.12 "
Gluten meal, . . . . .	0.06 "
Rowen, . . . . .	0.38 "
Corn ensilage, . . . . .	3.56 "
Nutritive ratio, . . . . .	1: 7.40
Total cost, . . . . .	1.85 cts.
Net cost, . . . . .	1.23 "
Manurial value obtainable, . . . . .	0.62 "

*Average Daily Fodder Rations, etc. — Concluded.*

## IV.

Corn meal, . . . . .	0.73 lbs.
Wheat bran, . . . . .	0.15 "
Gluten meal, . . . . .	0.07 "
Rowen, . . . . .	1.64 "
Nutritive ratio, . . . . .	1: 6.50
Total cost, . . . . .	2.53 cts.
Net cost, . . . . .	2.14 "
Manurial value obtainable, . . . . .	0.39 "

*Average Daily Fodder Rations used for Lambs Nos. 4, 5 and 6.*

## I.

Wheat bran, . . . . .	0.53 lbs.
Old-process linseed meal, . . . . .	0.27 "
Rowen, . . . . .	1.42 "
Nutritive ratio, . . . . .	1: 4.27
Total cost, . . . . .	2.08 cts.
Net cost, . . . . .	1.02 "
Manurial value obtainable, . . . . .	1.06 "

## II.

Wheat bran, . . . . .	0.56 lbs.
Gluten meal, . . . . .	0.28 "
Rowen, . . . . .	1.48 "
Nutritive ratio, . . . . .	1: 4.55
Total cost, . . . . .	2.20 cts.
Net cost, . . . . .	1.14 "
Manurial value obtainable, . . . . .	1.06 "

## III.

Wheat bran, . . . . .	0.48 lbs.
Gluten meal, . . . . .	0.24 "
Rowen, . . . . .	0.38 "
Corn ensilage, . . . . .	3.33 "
Nutritive ratio, . . . . .	1: 5.01
Total cost, . . . . .	1.69 cts.
Net cost, . . . . .	0.94 "
Manurial value obtainable, . . . . .	0.75 "

## IV.

Wheat bran, . . . . .	0.60 lbs.
Gluten meal, . . . . .	0.30 "
Rowen, . . . . .	1.34 "
Nutritive ratio, . . . . .	1: 4.51
Total cost, . . . . .	2.17 cts.
Net cost, . . . . .	1.13 "
Manurial value obtainable, . . . . .	1.04 "

*Summary of Cost of Above-stated Fodder Rations.**A. — Lambs 1, 2 and 3.*

FEEDING PERIODS.	I. Cents.	II. Cents.	III. Cents.	IV. Cents.
Total cost of feed consumed, . . . .	2.00	2.08	1.85	2.53
Manurial value obtainable (80 per cent.), .	1.01	0.78	0.62	0.39
Net cost of feed, . . . . .	0.99	1.30	1.23	2.14

*B. — Lambs 4, 5 and 6.*

Total cost of feed consumed, . . . .	2.08	2.20	1.69	2.17
Manurial value obtainable (80 per cent.), .	1.06	1.06	0.75	1.04
Net cost of feed, . . . . .	1.02	1.14	0.94	1.13

*5. Gain in Live Weight during Experiment.**Lot A.*

	Live Weight at the Beginning of Experiment (Pounds).	Live Weight at Close of Experiment (Pounds).	Gain in Live Weight during Experiment (Pounds).
1, . . . . .	47.50	93.50	46.00
2, . . . . .	60.50	98.75	38.25
3, . . . . .	58.00	109.75	51.75
Average, . . . . .	55.33	100.67	45.33

*Lot B.*

4, . . . . .	49.50	81.25	31.75
5, . . . . .	62.00	101.25	39.25
6, . . . . .	50.00	103.00	53.00
Average, . . . . .	53.83	95.17	41.33

Lot A gained in live weight per head, on an average, 0.224 pounds.

Lot B gained in live weight per head, on an average, 0.205 pounds.

*Amount of Raw Wool secured after the Close of the Experiment.**Lot A.*

	Live Weight with Wool (Pounds).	Live Weight after Shearing (Pounds).	Amount of Wool obtained (Pounds).
1, . . . . .	93.50	89.00	4.50
2, . . . . .	98.75	93.25	5.50
3, . . . . .	109.75	104.00	5.75
	302.00	286.25	15.75

*Lot B.*

4, . . . . .	81.25	76.00	5.25
5, . . . . .	101.25	97.00	4.25
6, . . . . .	108.00	97.75	5.25
	285.50	270.75	14.75

*6. Financial Statement.*

The wool was sold at 25 cents per pound and the pelt at 12.5 cents. The difference between the live weights of the animals 1, 2 and 3 at the close of the experiment, and their dressed weights, varied from 49 per cent. to 52 per cent., and averaged per head 51.2 per cent.; in case of animals 4, 5 and 6 it varied from 45 per cent. to 52 per cent., and averaged per head 48.6 per cent.

*Yield of Dressed Weight.*

1. 47.00 pounds, at 11 cents, . . . . .	\$5 17
2. 48.00 pounds, at 11 cents, . . . . .	5 28
3. 52.25 pounds, at 11 cents, . . . . .	5 75
147.25 pounds, . . . . .	\$16 20
4. 42.00 pounds, at 11 cents, . . . . .	\$4 62
5. 55.50 pounds, at 11 cents, . . . . .	6 11
6. 49.00 pounds, at 11 cents, . . . . .	5 39
146.50 pounds, . . . . .	\$16 12

*Yield of Dressed Weight — Concluded.**Lot A.*

	1.	2.	3.	Total.
Cost of lambs, . . . . .	\$1 89	\$2 41	\$2 31	\$20 58
Cost of feed consumed, . . . . .	4 30	4 46	5 21	
	\$6 19	\$6 87	\$7 52	
Value received for meat, . . . . .	\$5 17	\$5 28	\$5 75	\$25 07
Value received for wool and pelt, . . . . .	1 25	1 50	1 56	
Value of obtainable manure, . . . . .	1 41	1 46	1 69	
	\$7 83	\$8 24	\$9 00	

*Lot B.*

	4.	5.	6.	Total.
Cost of lambs, . . . . .	\$1 97	\$2 46	\$2 01	\$20 86
Cost of feed consumed, . . . . .	3 49	5 26	5 67	
	\$5 46	\$7 72	\$7 68	
Value received for meat, . . . . .	\$4 62	\$6 11	\$5 39	\$26 14
Value received for wool and pelt, . . . . .	1 44	1 19	1 44	
Value of obtainable manure, . . . . .	1 44	2 17	2 34	
	\$7 50	\$9 47	\$9 17	

*Market Cost of Fodder Articles for 1890-91, as compared with 1889-90.*

	1889-90.	1890-91.
	Per Ton.	Per Ton.
Corn meal, . . . . .	\$19 00	\$28 00
Wheat bran, . . . . .	17 00	25 00
Old-process linseed meal, . . . . .	27 00	26 00
Gluten meal, . . . . .	23 00	28 00
Corn ensilage, . . . . .	2 75	2 75
Rowen, . . . . .	15 00	15 00

*Total Cost of Feed consumed, counted on Basis of 1889-90 and of 1890-91.*

	1889-90.	1890-91.
Sheep 1, . . . . .	\$3 61	\$4 30
Sheep 2, . . . . .	3 74	4 46
Sheep 3, . . . . .	4 38	5 21
Sheep 4, . . . . .	3 00	3 49
Sheep 5, . . . . .	4 54	5 26
Sheep 6, . . . . .	4 98	5 67
	\$24 20	\$28 39

*Conclusions.*

1. The increase in live weight during the first feeding period is, in four out of six cases, lower than in any other period, and affects seriously the financial results of the whole experiment.

2. The total increase per head in live weight per day averages for the entire time of the experiment .23 pounds for Lot A (1, 2 and 3), and .22 pounds for Lot B (4, 5 and 6). In one case it amounts to .39 pounds per day (Lot A, 2, Period IV.); in nine cases it rises above .25 pounds.

3. The market cost of the daily individual fodder rations varies in different feeding periods from 1.69 cents to 2.53 cents. The rations that contain from three to four pounds of corn ensilage, in place of three-fourths of the rowen of other rations, furnish the cheapest daily diet (Period III., Lot A, 1.85 cents, and Lot B, 1.69 cents).

4. The market cost of the feed consumed during the experiment by the lambs of Lot A amounts per head to \$4.66, and in case of Lot B to \$4.81,—a difference of 15 cents. The three lambs of Lot A cost \$6.62, those of Lot B cost \$6.47; making cost of lambs and of the feed consumed \$20.58 in case of the former, and \$20.86 in case of the latter.



5. Dressed lambs, wool and pelts, brought, in case of Lot A, \$20.51, and in case of Lot B, \$20.19.

6. The obtainable manurial value of the feed consumed by the lambs of Lot A averages per head \$1.52, or one-third of the market cost of the feed, and amounts to \$1.95 per head, or two-fifths of the market cost of the feed consumed in case of the lambs of Lot B, — a difference of \$0.45 per head in favor of the latter, or \$4.56 for Lot A and \$5.95 for Lot B, — a difference of \$1.39 in favor of the latter.

7. The value of the obtainable manure, amounting from ten to eleven dollars for the entire operation, represents the profits of the experiment, aside from disposing of our home-raised fodder articles at a liberal retail market price.

8. The advance on the market cost of the concentrated commercial feed stuffs used in the experiment of 1890-91, as compared with that of 1889-90, amounts to \$4.19 as far as the feed consumed is concerned, or 70 cents per head.

*Sheep No. 1.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn Ensilage.					
<b>1890-91.</b>											
Sept. 30 to Oct. 13,	-	0.45	0.23	-	1.25	-	1.68	0.11	15.27	1:4.30	47.50
Oct. 14 to Jan. 19,	0.61	0.12	-	0.06	1.39	-	1.89	0.20	9.45	1:6.50	60.00
Jan. 27 to March 2,	0.58	0.12	-	0.06	0.40	3.53	1.69	0.21	8.05	1:7.39	74.50
March 10 to April 20,	0.73	0.15	-	0.07	1.63	-	2.22	0.33	6.73	1:6.51	86.50

*Total Amount of Feed consumed from Sept. 30, 1890, to April 20, 1891.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
118.27 pounds corn meal, . . . .	102.59	\$1 66	\$0 39
29.98 pounds wheat bran, . . . .	26.35	0 37	0 19
3.17 pounds old-process linseed meal, .	2.89	0 04	0 08
11.83 pounds gluten meal, . . . .	10.54	0 17	0 09
247.25 pounds rowen, . . . .	212.88	1 85	0 97
155.00 pounds corn ensilage, . . . .	30.18	0 21	0 09
	385.43	\$4 30	\$1 76

Pounds.

Live weight of animal at beginning of experiment, . . . .	47.50
Live weight at time of killing, . . . .	93.50
Live weight gained during experiment, . . . .	46.00
Average gain in weight per day, . . . .	0.23
Dressed weight of animal, . . . .	47.00
Loss in weight by dressing, . . . . 46.5 pounds, or 49.73 per cent.	
Pounds of dry matter fed produced 1 pound of live weight, . . . .	8.38
Cost of feed per pound of live weight gained, . . . .	9.35 cents.
Net cost of feed per pound gained after deducting 8 per cent. of manurial value, . . . .	5.83 cents.

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*Sheep No. 2.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn Ensilage.					
1890-91.											
Sept. 30 to Oct. 13,	-	0.53	0.27	-	1.46	-	1.97	0.07	28.14	1:4.30	60.50
Oct. 14 to Jan. 19,	0.60	0.12	-	0.06	1.33	-	1.83	0.13	14.08	1:6.51	69.00
Jan. 27 to March 2,	0.63	0.13	-	0.06	0.50	3.80	1.88	0.28	6.71	1:7.38	80.00
March 10 to April 20,	0.75	0.15	-	0.08	1.73	-	2.34	0.30	6.00	1:6.50	92.50

*Total Amount of Feed consumed from Sept. 30, 1890, to April 20, 1891.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
121.73 pounds corn meal, . . .	105.59	\$1 70	\$0 40
31.75 pounds wheat bran, . . .	27.91	0 40	0 20
3.70 pounds old-process linseed meal, .	3.38	0 05	0 03
12.17 pounds gluten meal, . . .	10.84	0 17	0 09
254.00 pounds rowen, . . .	218.69	1 91	1 00
169.50 pounds corn ensilage, . . .	93.00	0 23	0 10
	999.41	\$4 46	\$1 82

	Pounds.
Live weight of animal at beginning of experiment, . . .	60.50
Live weight at time of killing, . . .	98.75
Live weight gained during experiment, . . .	38.25
Average gain in weight per day, . . .	0.19
Dressed weight of animal, . . .	48.00
Loss in weight by dressing, . . . 50.75 pounds, or 51.39 per cent.	
Pounds of dry matter fed produced 1 pound of live weight, . . .	10.44
Cost of feed per pound of live weight gained, . . .	11.66 cents.
Net cost of feed per pound gained after deducting 8 per cent. of manurial value, . . .	7.29 cents.

*Sheep No. 3.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn Ensilage.					
<b>1890-91.</b>											
Sept. 30 to Oct. 13,	-	0.53	0.27	-	1.50	-	2.00	0.27	7.41	1:4.36	59.75
Oct. 14 to Jan. 19,	0.60	0.14	-	0.07	1.63	-	2.18	0.24	9.08	1:6.50	72.00
Jan. 27 to March 2,	0.75	0.15	-	0.08	0.50	4.91	2.24	0.24	9.31	1:7.43	90.75
March 10 to April 20,	0.90	0.18	-	0.09	2.05	-	2.79	0.27	13.33	1:6.50	104.75

*Total Amount of Feed consumed from Sept. 30, 1890, to April 20, 1891.*

	Dry Matter (Pounds)	Cost.	Manurial Value.
141.54 pounds corn meal, . . .	122.77	\$1 98	\$0 46
35.71 pounds wheat bran, . . .	31.39	0 45	0 22
3.70 pounds old-process linseed meal, .	3.98	0 05	0 03
14.15 pounds gluten meal, . . .	12.61	0 20	0 11
299.25 pounds rowen, . . .	256.66	2 24	1 17
209.50 pounds corn ensilage, . . .	40.79	0 29	0 12
	467.60	\$5 21	\$2 11

	Pounds.
Live weight of animal at beginning of experiment, . . .	58.00
Live weight at time of killing, . . . . .	109.75
Live weight gained during experiment, . . . . .	51.75
Average gain in weight per day, . . . . .	0.25
Dressed weight of animal, . . . . .	52.25
Loss in weight by dressing, . . . 57.50 pounds, or 52.39 per cent.	
Pounds of dry matter fed produced 1 pound of live weight, . .	9.04
Cost of feed per pound of live weight gained, . . . . .	10.07 cents.
Net cost of feed per pound gained after deducting 8 per cent. of manurial value, . . . . .	6.32 cents.

*Sheep No. 4.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn Ensilage.					
1890-91.											
Sept. 30 to Oct. 13,	-	0.50	0.25	-	1.21	-	1.71	0.18	9.50	1:4.20	50.25
Oct. 14 to Jan. 19,	-	0.44	-	0.22	0.98	-	1.42	0.13	10.92	1:4.42	59.00
Jan. 27 to March 2,	-	0.42	-	0.21	0.41	3.00	1.48	0.21	7.05	1:5.00	68.25
March 10 to April 20,	-	0.57	-	0.28	1.42	-	1.98	0.26	7.62	1:4.51	78.25

*Total Amount of Feed consumed from Sept. 30, 1890, to April 20, 1891.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
95.33 pounds wheat bran, . . . .	83.79	\$1 19	\$0 59
3.50 pounds old-process linseed meal, .	3.19	0 05	0 03
44.17 pounds gluten meal, . . . .	39.36	0 62	0 34
193.25 pounds rowen, . . . . .	166.39	1 45	0 76
130.50 pounds corn ensilage, . . . .	25.41	0 18	0 08
	318.14	\$3 49	\$1 80

	Pounds.
Weight of animal at beginning of experiment, . . . .	49.50
Live weight at time of killing, . . . . .	81.25
Live weight gained during experiment, . . . . .	31.75
Average gain in weight per day, . . . . .	0.16
Dressed weight of animal, . . . . .	42.00
Loss in weight by dressing, . . . . . 39.25 pounds, or 48.31 per cent.	
Pounds of dry matter fed produced 1 pound live weight, . . . .	10.02
Cost of feed per pound of live weight gained, . . . . .	10.99 cents.
Net cost of feed per pound gained after deducting 8 per cent. of manurial value, . . . . .	5.76 cents.

*Sheep No. 5.*

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn Ensilage.					
1890-91.											
Sept. 30 to Oct. 13,	-	0.57	0.29	-	1.71	-	2.23	0.21	10.62	1:4.36	62.50
Oct. 14 to Jan. 19,	-	0.67	-	0.33	1.78	-	2.41	0.19	12.68	1:4.56	76.00
Jan. 27 to March 2,	-	0.65	-	0.33	0.43	4.76	2.16	0.29	7.45	1:5.02	90.50
March 10 to April 20,	-	0.72	-	0.36	1.87	-	2.56	8.24	10.66	1:4.53	100.25

*Total Amount of Feed consumed from Sept. 30, 1890, to April 20, 1891.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
136.50 pounds wheat bran, . . . .	119.97	\$1 71	\$0 85
4.00 pounds old-process linseed meal, .	3.65	0 05	0 04
64.25 pounds gluten meal, . . . .	57.25	0 91	0 49
308.50 pounds rowen, . . . .	265.62	2 31	1 21
202.00 pounds corn ensilage, . . . .	39.33	0 28	0 12
	485.82	\$5 26	\$2 71

	Pounds.
Live weight of animal at beginning of experiment, . . . .	62.00
Live weight at time of killing, . . . .	101.25
Live weight gained during experiment, . . . .	39.25
Average gain in weight per day, . . . .	0.19
Dressed weight of animal, . . . .	55.50
Loss in weight by dressing, . . . . 45.75 pounds, or 45.16 per cent.	
Pounds of dry matter fed produced 1 pound of live weight, . .	12.38
Cost of feed per pound of live weight gained, . . . .	13.40 cents.
Net cost of feed per pound gained after deducting 8 per cent. of manurial value, . . . .	7.06 cents.

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## Sheep No. 6.

FEEDING PERIODS.	FEED CONSUMED (POUNDS) PER DAY.						Pounds of Dry Matter in Daily Fodder consumed.	Gain in Live Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound of Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Old-process Linseed Meal.	Gluten Meal.	Rowen.	Corn Ensilage.					
1890-91.											
Sept. 30 to Oct. 13,	-	0.53	0.27	-	1.34	-	1.87	0.14	13.36	1:4.24	50.50
Oct. 14 to Jan. 19,	-	0.67	-	0.33	1.89	-	2.51	0.27	9.30	1:4.61	65.60
Jan. 27 to March 2,	-	0.67	-	0.33	0.60	5.23	2.33	0.29	8.03	1:5.15	84.00
March 10 to April 20,	-	0.87	-	0.43	2.50	-	3.29	0.27	12.19	1:4.62	90.25

*Total Amount of Feed consumed from Sept. 30, 1890, to April 20, 1891.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
142.74 pounds wheat bran, . . . .	125.45	\$1 78	\$0 88
3.70 pounds old-process linseed meal, .	3.38	0 05	0 03
67.67 pounds gluten meal, . . . .	60.29	0 95	0 52
345.75 pounds rowen, . . . .	297.69	2 59	1 36
220.00 pounds corn ensilage, . . . .	42.83	0 30	0 13
	529.64	\$5 67	\$2 92

	Pounds.
Live weight of animal at beginning of experiment, . . . .	50.00
Live weight at time of killing, . . . .	103.00
Live weight gained during experiment, . . . .	53.00
Average gain in weight per day, . . . .	0.26
Dressed weight of animal, . . . .	49.00
Loss in weight by dressing, . . . . 54.00 pounds, or 52.43 per cent.	
Pounds of dry matter fed produced 1 pound of live weight, . .	9.99
Cost of feed per pound of live weight gained, . . . .	10.70 cents.
Net cost of feed per pound gained after deducting 8 per cent. of manurial value, . . . .	5.62 cents

*Fodder Articles used in the Experiment.**Corn Meal (Average).*

1890-1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents	Nutritive Ratio.
Moisture at 100° C., . . .	13.26	265.20	-	-	} 1: 8.62
Dry matter, . . . . .	86.74	1,734.80	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.72	34.40	-	-	
“ cellulose, . . . . .	2.28	45.60	21.89	48	
“ fat, . . . . .	4.90	98.00	83.30	85	
“ protein (nitrogenous matter), . . . . .	12.94	258.80	204.45	79	
Non-nitrogenous extract matter, . . . . .	78.16	1,563.20	1,531.94	98	
	100.00	2,000.00	1,841.58	-	

*Wheat Bran (Average).*

1890-1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	12.11	242.20	-	-	} 1: 3.86
Dry matter, . . . . .	87.89	1,757.80	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	7.40	148.00	-	-	
“ cellulose, . . . . .	12.17	243.40	58.42	24	
“ fat, . . . . .	5.04	100.80	71.57	71	
“ protein (nitrogenous matter), . . . . .	18.48	369.60	288.29	78	
Non-nitrogenous extract matter, . . . . .	56.91	1,138.20	876.41	77	
	100.00	2,000.00	1,294.69	-	



*Old-process Linseed Meal.*

1890-1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	8.72	174.40	-	-	1 : 1.93
Dry matter, . . . . .	91.28	1,825.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	5.96	119.20	-	-	
“ cellulose, . . . . .	8.23	164.60	42.79	26	
“ fat, . . . . .	9.87	197.40	179.63	91	
“ protein (nitrogenous matter), . . . . .	36.19	723.80	629.70	87	
Non-nitrogenous extract matter, . . . . .	39.75	795.00	723.45	91	
	100.00	2,000.00	1,575.57	-	

*Gluten Meal.*

1890-1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	10.90	218.00	-	-	1 : 2.44
Dry matter, . . . . .	89.10	1,782.00	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.02	20.40	-	-	
“ cellulose, . . . . .	1.28	25.60	15.87	62	
“ fat, . . . . .	7.36	147.20	125.12	85	
“ protein (nitrogenous matter), . . . . .	34.79	695.80	549.68	79	
Non-nitrogenous extract matter, . . . . .	55.55	1,111.00	1,011.01	91	
	100.00	2,000.00	1,701.68	-	

*Rowen (Average).*

1890-1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	13.90	278.00	—	—	1:6.85
Dry matter, . . . . .	86.10	1,722.00	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	8.28	165.60	—	—	
“ cellulose, . . . . .	28.88	577.60	369.66	64	1:9.26
“ fat, . . . . .	3.91	78.20	35.97	46	
“ protein (nitrogenous matter), . . . . .	13.45	269.00	166.78	62	
Non-nitrogenous extract matter, . . . . .	45.48	909.60	600.84	66	
	100.00	2,000.00	1,172.75	—	

*Corn Ensilage.*

1890-1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	80.53	1,610.60	—	—	1:9.26
Dry matter, . . . . .	19.47	389.40	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.73	134.60	—	—	
“ cellulose, . . . . .	26.90	538.00	387.36	72	1:9.26
“ fat, . . . . .	3.27	65.40	49.05	75	
“ protein (nitrogenous matter), . . . . .	8.97	179.40	134.55	75	
Non-nitrogenous extract matter, . . . . .	54.13	1,082.60	736.17	68	
	100.00	2,000.00	1,307.13	—	

## IV.

THREE FEEDING EXPERIMENTS WITH PIGS  
(THOROUGHBREDS).

1890-1891.

Breeds: Small Yorkshires, Berkshires, Poland Chinas, Tamworths.

Feed: Creamery buttermilk, home skim-milk, corn meal, wheat bran, gluten meal (Chicago variety).

The general management of these experiments was similar to that adopted in our late pig-feeding experiments with grades. From two to three animals of each breed served in our trial.

Three experiments were carried on in succession. The Small Yorkshires were kindly furnished by Messrs. Warren Heustis & Sons, Belmont, Mass.; Berkshires by Col. Henry L. Russell, Milton, Mass.; Poland Chinas by Mr. Smith Harding, South Deerfield, Mass.; Tamworths by Mr. Joshua M. Sears, Boston, Mass.

*Weight of Animals at the Beginning of the Experiments.*

I.	{	Small Yorkshires, . . . . .	24 to 26 pounds.
		Berkshires, . . . . .	26 to 36 pounds.
		Poland Chinas, . . . . .	20 to 22 pounds.
		Tamworths, . . . . .	21 to 24 pounds.
II.	{	Small Yorkshires, . . . . .	42 to 52 pounds.
		Berkshires, . . . . .	20 to 23 pounds.
		Poland Chinas, . . . . .	42 to 50 pounds.
		Tamworths, . . . . .	34 to 38 pounds.
III.	{	Small Yorkshires, . . . . .	26 to 27 pounds.
		Berkshires, . . . . .	23 to 26 pounds.
		Poland Chinas, . . . . .	23.5 to 24 pounds.
		Tamworths, . . . . .	38 to 42 pounds.

*Average Composition of Fodder Rations used during the Three Feeding Periods of Each Feeding Experiment.*

*Experiment I.*

FEEDING PERIODS.	Corn Meal.	Wheat Bran.	Gluten Meal.	Skim-milk.	Buttermilk.
	Ounces.	Ounces.	Ounces.	Quarts.	Quarts.
I., . . . . .	10	3½	7	—	5
II., . . . . .	29½	9½	9½	—	5
III., . . . . .	57	13½	13½	5	—

*Experiment II.*

I., . . . . .	6	6	12	3	—
II., . . . . .	22½	8½	8½	3½	—
III., . . . . .	35	5½	5½	4	—

*Experiment III.*

I., . . . . .	11	6	12	5½	—
II., . . . . .	31½	11½	11½	5	—
III., . . . . .	52	11	11	5	—

The amount of milk used was controlled by our daily supply and by the number of pigs under observation. During the first experiment creamery buttermilk was fed during the two first feeding periods; during the remaining time home-made skim-milk alone was used. As a general rule during the entire experiment the following system was adopted for compounding the daily diet in different feeding periods: —

Period I. For each one quart skim-milk to two ounces of corn meal.

Period II. For each, one quart skim-milk to four ounces of corn meal.

Period III. For each, one quart skim-milk to six ounces of corn meal.

The daily quantity of this feed was governed by the appetite of each animal. Whenever the supply of either kind of milk, or of both kinds, was exhausted, the additional feed called for was prepared in the following manner : —

Period I.	{	Wheat bran, one weight part, . . . .	}	Nutritive Ratio. 1 : 2.80
		Gluten meal, two weight parts, . . . .		
Period II.	{	Corn meal, one weight part, . . . .	}	1 : 3.80
		Wheat bran, one weight part, . . . .		
		Gluten meal, one weight part, . . . .		
Period III.	{	Corn meal, two weight parts, . . . .	}	1 : 4.35
		Wheat bran, one weight part, . . . .		
		Gluten meal, one weight part, . . . .		

*The entire management of the feeding was divided, as will be noticed, into three periods, as far as the nutritive character of the daily diet was concerned.*

	Live Weight.	Nutritive Ratio.
Period I., . . . . .	20 to 90 pounds, . . . .	1 : 2.80
Period II., . . . . .	90 to 130 pounds, . . . .	1 : 3.80
Period III., . . . . .	130 to 200 pounds, . . . .	1 : 4.35

During the summer season the feed was given twice a day; during the winter season, three times. Whenever the milk did not satisfy the thirst of the animals warm water was added to the grain to meet the temporary wants.

The results of the two first experiments, being more of an experimental character, are subsequently given in a brief abstract; the third experiment is reported also in regard to all details of a special interest. Those animals which for more than a few days refused to consume a fair share of their daily diet are excluded from the record, in common with a few losses soon after their arrival during our first and second experiment.

*Summary of Experiment I. (May 13 to Oct. 15, 1890).*

	Corn Meal (Pounds).	Buttermilk (Quarts).	Skim-milk (Quarts).	Wheat Bran (Pounds).	Gluten Meal (Pounds).	Live Weight gained during Experiment.	Dressed Weight gained during Experiment.	Cost per Pound of Dressed Fork (Cents).
Small Yorkshires, 2 pigs, .	560.35	1,129.00	355.00	153.74	187.18	367.25	311.75	4.79
Poland China, . . .	305.10	558.50	177.50	95.65	116.38	215.50	180.00	4.57
Berkshires, 3 pigs, . .	721.71	1,491.50	532.50	211.42	250.36	512.25	415.50	4.80
Tamworths, 2 pigs, . .	478.53	889.00	355.00	137.29	156.50	354.75	283.75	4.52

*Local Market Cost of Fodder Articles used during Experiment I.*

Corn meal, per ton, . . . . .	\$24 00
Wheat bran, per ton, . . . . .	19 00
Gluten meal, per ton, . . . . .	25 00
Buttermilk, per gallon, . . . . .	1 cent.
Skim-milk, per gallon, . . . . .	18 cents.

Valuation of essential fertilizing constituents in the above articles of fodder used: Nitrogen, 17 cents; phosphoric acid, 6 cents; potassium oxide,  $4\frac{1}{2}$  cents per pound.

	Corn Meal.	Wheat Bran.	Gluten Meal.	Butter- milk.	Skim- milk.
Moisture, . . . . .	12.39	11.52	8.48	93.34	89.78
Nitrogen, . . . . .	1.466	2.600	5.358	.391	.520
Phosphoric acid, . . . .	.707	2.870	.425	.135	.190
Potassium oxide, . . . .	.435	1.620	.045	.143	.200
Valuation per 2,000 pounds, .	\$6 22	\$13 74	\$19 13	\$1 62	\$2 18

*Summary of Experiment II. (Nov. 18, 1890, to April 19, 1891).*

	Corn Meal (Pounds).	Skim-milk (Quarts).	Wheat Bran (Pounds).	Gluten Meal (Pounds).	Live Weight gained during Experiment.	Dressed Weight gained during Experiment.	Cost per Pound of Dressed Pork (Cents).
Berkshire, No. 1, . . .	159.54	511.00	43.80	60.49	136.50	112.77	5.19
Berkshire, No. 2, . . .	149.06	511.00	35.65	50.46	129.50	105.14	5.30
Poland China, No. 1, . . .	223.54	488.50	69.96	84.96	157.00	132.35	5.50
Poland China, No. 2, . . .	170.68	491.00	48.94	63.75	114.00	95.73	6.28
Small Yorkshire, No. 1, . . .	215.40	515.00	60.01	71.82	151.75	127.11	5.53
Small Yorkshire, No. 2, . . .	218.84	515.00	63.70	82.26	146.00	123.56	5.84

*Local Market Value of the Various Articles of Fodder used  
during Experiment II.*

Corn meal, per ton, . . . . .	\$27 00
Skim-milk, per gallon, . . . . .	1.8 cents.
Wheat bran, per ton, . . . . .	\$25 00
Gluten meal, per ton, . . . . .	23 00

Valuation of essential fertilizing constituents of the above fodder articles: Nitrogen, 15 cents; phosphoric acid, 5½ cents; potassium oxide, 4½ cents per pound.

	Corn Meal.	Skim-milk.	Wheat Bran.	Gluten Meal.
Moisture, . . . . .	13.26	89.78	12.11	10.90
Nitrogen, . . . . .	1.796	.520	2.599	4.959
Phosphoric acid, . . . . .	.707	.190	2.845	.425
Potassium oxide, . . . . .	.435	.200	1.625	.045
Valuation per 2,000 pounds, . . .	\$6 56	\$1 95	\$12 39	\$15 38

*Summary of Experiment III. (May 12 to Sept. 7, 1891).*

	Corn Meal (Pounds).	Skim-milk (Quarts).	Wheat Bran (Pounds).	Gluten Meal (Pounds).	Live Weight gained during Experiment.	Dressed Weight gained during Experiment.	Cost per Pound of Dressed Pork (Cents).
Berkshire, No. 1, . . .	237.70	631.00	80.46	105.07	177.50	142.96	6.20
Berkshire, No. 2, . . .	221.66	631.00	70.82	94.51	169.25	141.04	5.98
Small Yorkshire, No. 1, . .	215.60	680.00	53.45	67.93	156.00	126.86	6.25
Small Yorkshire, No. 2, . .	268.53	794.00	58.68	73.16	174.00	145.36	6.46
Poland China, No. 1, . . .	208.44	589.00	59.29	75.16	171.50	136.61	5.54
Poland China, No. 2, . . .	204.31	589.00	61.10	74.42	156.50	124.77	6.03
Tamworth, No. 1, . . .	210.07	510.00	73.24	92.38	143.00	126.83	6.06
Tamworth, No. 2, . . .	206.57	510.00	72.46	91.73	141.75	114.90	6.59

*Local Market Value of the Various Articles of Fodder used  
during Experiment III.*

Corn meal, per ton, . . . . .	\$31 00
Skim-milk, per gallon, . . . . .	1.8 cents.
Wheat bran, per ton, . . . . .	\$23 00
Gluten meal, per ton, . . . . .	27 00

Valuation of the essential fertilizing constituents of the above fodder articles: Nitrogen, 15 cents; phosphoric acid, 5½ cents; potassium oxide, 4½ cents per pound.

	Corn Meal.	Skim-milk.	Wheat Bran.	Gluten Meal.
Moisture, . . . . .	15.31	91.18	12.99	11.11
Nitrogen, . . . . .	1.651	.445	2.249	4.741
Phosphoric acid, . . . . .	.693	.163	2.793	.413
Potassium oxide, . . . . .	.426	.172	1.592	.044
Valuation per 2,000 pounds, . .	\$6 10	\$1 67	\$11 25	\$14 72



*Summary of the Three Feeding Experiments, regarding the Character and Quantity of Feed consumed per Pound of Live Weight and Dressed Weight produced.*

*I. May to October, 1890.*

BREED.	Number of Animals on Trial.	Nutritive Ratio, Period I.	Nutritive Ratio, Period II.	Nutritive Ratio, Period III.	Dry Matter consumed per Pound of Live Weight (Pounds).	Dry Matter consumed per Pound of Dressed Weight (Pounds).
Small Yorkshire, . . . . .	2	1:2.79	1:3.90	1:4.49	2.82	3.32
Berkshire, . . . . .	3	1:2.82	1:3.85	1:4.47	2.69	3.31
Poland China, . . . . .	1	1:2.76	1:3.84	1:4.50	2.67	3.28
Tamworth, . . . . .	2	1:2.85	1:3.85	1:4.48	2.50	3.13

*II. November, 1890, to April, 1891.*

Small Yorkshire, . . . . .	2	1:2.88	1:3.80	1:4.38	2.87	3.42
Berkshire, . . . . .	2	1:2.89	1:3.76	1:4.35	2.49	3.04
Poland China, . . . . .	1	1:2.85	1:3.74	1:4.39	2.80	3.32
Tamworth, . . . . .	-	-	-	-	-	-

*III. May to September, 1891.*

Small Yorkshire, . . . . .	2	1:3.14	1:4.19	1:4.80	2.77	3.36
Berkshire, . . . . .	2	1:3.13	1:4.22	1:4.80	2.71	3.31
Poland China, . . . . .	2	1:3.14	1:4.23	1:4.90	2.49	3.12
Tamworth, . . . . .	2	1:3.12	1:4.26	1:4.93	2.94	3.48

*Summary of the Three Feeding Experiments, regarding Gain in Weight, Cost of Feed and Rate of Shrinkage of Pork dressed for the Market.*

BREED.	Number of Animals on Trial.	Average Live Weight of Animals on Trial at Beginning.	Average Live Weight of Animals at Time of Killing.	Number of Days on Trial.	Average Gain in Live Weight during Experiment (Pounds).	Average Gain in Live Weight per Day (Pounds).	Average Cost of Feed per Pound of Dressed Pork (Cents).	Average Shrinkage in Weight by Dressing (Per Cent.).
<b>I.</b>								
Small Yorkshire, . . . . .	2	26.80	212.10	156	185.60	1.19	4.79	15.09
Berkshire, . . . . .	3	21.50	192.00	142	170.70	1.20	1.80	18.87
Poland China, . . . . .	1	26.25	241.75	156	215.50	1.38	4.57	16.44
Tamworth, . . . . .	2	22.75	199.90	128	177.00	1.38	4.52	20.01
<b>II.</b>								
Small Yorkshire, . . . . .	2	47.38	196.20	148	148.80	1.01	5.19	15.80
Berkshire, . . . . .	2	21.12	154.12	148	133.00	0.90	4.80	18.01
Poland China, . . . . .	1	46.00	207.00	141	157.00	1.11	4.98	15.87
Tamworth, . . . . .	-	-	-	-	-	-	-	-
<b>III.</b>								
Small Yorkshire, . . . . .	2	26.25	191.25	144.5	165.00	1.15	5.61	17.57
Berkshire, . . . . .	2	24.12	197.50	128	173.40	1.35	5.32	18.06
Poland China, . . . . .	2	23.60	187.60	119	163.50	1.38	6.09	20.37
Tamworth, . . . . .	2	39.60	182.00	100	142.80	1.42	5.52	15.30

Basis of valuation per ton: Corn meal, \$24; wheat bran, \$19; gluten meal, \$25; skim-milk, per gallon, 1.8 cents; buttermilk, per gallon, 1.0 cent.

*Summary of Cost of Feed consumed for the Production of One Pound of Dressed Pork, based on the Ruling Market Price of the Fodder Articles when used.*

BREED.	EXPERIMENT I.			EXPERIMENT II.			EXPERIMENT III.		
	Total Cost.	Net Cost.	Obtainable Manurial Value.	Total Cost.	Net Cost.	Obtainable Manurial Value.	Total Cost.	Net Cost.	Obtainable Manurial Value.
Small Yorkshire, . . .	Cents. 4.79	Cents. 3.14	Cents. 1.65	Cents. 5.68	Cents. 4.14	Cents. 1.54	Cents. 6.36	Cents. 4.86	Cents. 1.50
Berkshire, . . . . .	4.80	3.18	1.67	5.20	3.74	1.46	6.07	4.59	1.48
Poland China, . . . .	4.57	2.98	1.59	5.50	4.00	1.50	5.79	4.40	1.39
Tamworth, . . . . .	4.52	2.97	1.55	-	-	-	6.33	4.78	1.55

*Local Market Cost of the Various Articles of Fodder used during the Three Experiments.*

	Experiment I.	Experiment II.	Experiment III.
Corn meal, per ton, . .	\$24 00	\$27 00	\$31 00
Wheat bran, per ton, . .	19 00	25 00	23 00
Gluten meal, per ton, . .	25 00	28 00	27 00
Buttermilk, per gallon, . .	0 01	-	-
Skim-milk, per gallon, . .	0 018	0 018	0 018

*Relative Cost of Feed per Pound of Dressed Pork (Cents), based on the Lowest and Highest Market Price.*

	I.	II.
Corn meal, per ton, . . . . .	\$24 00	\$31 00
Wheat bran, per ton, . . . . .	19 00	23 00
Gluten meal, per ton, . . . . .	25 00	27 00
Skim-milk, per gallon, . . . . .	1.8 cents.	1.8 cents.
Buttermilk, per gallon, . . . . .	1.0 cent.	1.0 cent.

## I.

	Experiment I.	Experiment II.	Experiment III.
	Cents.	Cents.	Cents.
Small Yorkshire, No. 1, . . . . .	4.79	5.04	5.53
Small Yorkshire, No. 2, . . . . .		5.34	5.68
Berkshire, No. 1, . . . . .	4.80	4.78	5.43
Berkshire, No. 2, . . . . .		4.81	5.21
Berkshire, No. 3, . . . . .		—	—
Poland China, No. 1, . . . . .	4.57	4.98	4.87
Poland China, No. 2, . . . . .	—	—	5.30
Tamworth, No. 1, . . . . .	4.52	—	5.28
Tamworth, No. 2, . . . . .		—	5.76

## II.

Small Yorkshire, No. 1, . . . . .	5.58	5.80	6.25
Small Yorkshire, No. 2, . . . . .		5.30	6.46
Berkshire, No. 1, . . . . .	5.57	5.40	6.20
Berkshire, No. 2, . . . . .		5.42	5.93
Berkshire, No. 3, . . . . .		—	—
Poland China, No. 1, . . . . .	5.33	5.75	5.54
Poland China, No. 2, . . . . .	—	—	6.03
Tamworth, No. 1, . . . . .	5.26	—	6.06
Tamworth, No. 2, . . . . .		—	6.59

*Conclusions.*

1. *The average amount of dry matter consumed per pound of dressed pork produced differs for different breeds as follows: First experiment, in case of Tamworths and Poland Chinas, from 3.13 to 3.20 pounds; in case of Berkshires and Small Yorkshires, from 3.31 to 3.32 pounds. Second experiment, in case of Berkshires and Small Yorkshires, from 3.04 to 3.42 pounds; Poland Chinas, 3.32 pounds; Tamworths ruled out, on account of sickness in the second experiment. Third experiment, in case of Poland Chinas and Tamworths, from 3.12 to 3.48 pounds; and in case of Berkshires and Small Yorkshires, from 3.31 to 3.36 pounds. Summing up the results of the three experiments in this connection, it appears that in our case the larger build breeds lead the smaller breeds in two out of three cases. The difference between breeds is apparently not more marked than the difference between animals of the same breed.*

2. *The average gain in live weight per day differs in the first trial, between Small Yorkshires and Berkshires, from*

1.19 to 1.20 pounds; Poland Chinas and Tamworths are even, 1.38 pounds; in the second experiment, Small Yorkshires 1.01 to Berkshires .9 pounds; Poland Chinas 1.01 pounds; in the third experiment, Small Yorkshires 1.15, Berkshires 1.35, Poland Chinas 1.38 and Tamworths 1.42 pounds. The Berkshires lead the Small Yorkshires in two out of three experiments, while the Poland Chinas and Tamworths show practically no difference in that respect.

3. *The cost of feed per pound of dressed pork produced* varies in case of different breeds in the successive experiments as follows: First experiment, Small Yorkshires and Berkshires, from 4.79 to 4.80 cents, and Tamworths and Poland Chinas 4.52 to 4.57 cents; second experiment, Berkshires and Small Yorkshires 4.80 to 5.19 cents, Poland Chinas 4.98 cents; third experiment, Berkshires and Small Yorkshires from 5.32 to 5.61 cents, and Poland Chinas and Tamworths from 5.09 to 5.52 cents. The Berkshires lead the Small Yorkshires in two out of three trials, and the Poland Chinas and Tamworths compare well with each other in two trials. The cost of feed in the previous statement is based on the contemporary market price of the different grain feeds, which during the third experiment were exceptionally high, as may be seen from previous reports.

4. The average net cost of the feed consumed per pound of dressed pork produced, allowing a loss of 30 per cent. of the essential manurial constituents of the feed consumed, compares as follows: First experiment, Small Yorkshires, 3.14 cents; Berkshires, 3.13 cents; Poland Chinas, 2.98 cents; Tamworths, 2.92 cents. Second experiment, Small Yorkshires, 4.14 cents; Berkshires, 4.70 cents; Poland Chinas, 4.00 cents. Third experiment, Small Yorkshires, 4.86 cents; Berkshires, 4.59 cents; Poland Chinas, 4.40 cents; and Tamworths, 4.78 cents. The value of the obtainable manure averages in the first experiment, per pound of dressed pork sold, 1.61 cents; second experiment, 1.50 cents; and in the third experiment, 1.48 cents, — which is equal to from one-quarter to one-third of the total cost of the feed consumed. The commercial value of the manurial constituents of the feed consumed during our three feeding experiments amounts to \$12.39, of which from eight to nine dollars' worth may be saved.

*Detailed Statement of Third Experiment.**Small Yorkshire, No. 1 (Experiment III.).*

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day during Period (Pounds).
<b>1891.</b>								
April 28 to June 22, .	37.88	303.00	14.48	28.96	1:3.14	26.00	83.25	1.02
June 23 to July 27, .	63.58	175.00	19.75	19.75	1:4.19	83.25	127.00	1.25
July 28 to Sept. 7, .	114.19	202.00	19.23	19.22	1:4.82	127.00	182.00	1.31

*Total Amount of Feed consumed from April 28 to Sept. 7, 1891.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
215.60 pounds corn meal, . . .	182.59	\$3 34	\$0 66
680.00 quarts skim-milk, . . .	130.14	3 06	1 23
53.45 pounds wheat bran, . . .	46.51	0 61	0 30
67.93 pounds gluten meal, . . .	60.38	0 92	0 50
	419.62	\$7 93	\$2 69

	Pounds.
Live weight of animal at beginning of experiment, . . .	26.00
Live weight at time of killing, . . . . .	182.00
Live weight gained during experiment, . . . . .	156.00
Dressed weight at time of killing, . . . . .	148.00
Loss in weight by dressing, . . . . .34 pounds, or 18.68 per cent.	
Dressed weight gained during experiment, . . . . .	126.86

2.69 pounds of dry matter fed yielded 1 pound of live weight, and  
3.31 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for production of 1 pound of dressed pork, 6.25 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing a  
loss of 30 per cent. of the manurial value of the feed, 4.77 cents. .

*Detailed Statement of Third Experiment—Continued.**Small Yorkshire, No. 2 (Experiment III.).*

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1891.</b>								
April 28 to June 22, .	37.88	303.00	14.48	28.96	1:3.14	26.50	77.75	0.92
June 23 to July 27, .	63.50	175.00	19.75	19.75	1:4.19	77.75	119.50	1.19
July 28 to Sept. 30, .	167.15	316.00	24.45	24.45	1:4.78	119.50	200.50	1.25

*Total Amount of Feed consumed from April 28 to Sept. 30, 1891.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
268.53 pounds corn meal, . . .	227.42	\$4 16	\$0 82
794.00 quarts skim-milk, . . .	151.97	3 57	1 44
58.68 pounds wheat bran, . . .	51.06	0 67	0 33
73.16 pounds gluten meal, . . .	65.03	0 99	0 54
	495.48	\$9 39	\$3 13

	Pounds.
Live weight of animal at beginning of experiment, . . .	26.50
Live weight at time of killing, . . . . .	200.50
Live weight gained during experiment, . . . . .	174.00
Dressed weight at time of killing, . . . . .	167.50
Loss in weight by dressing, . . . . . 33 pounds, or 16.46 per cent.	
Dressed weight gained during experiment, . . . . .	145.36

2.85 pounds of dry matter fed yielded 1 pound of live weight, and 3.41 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for production of 1 pound of dressed pork, 6.46 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing a loss of 30 per cent. of manurial value of feed, 4.95 cents.

*Detailed Statement of Third Experiment — Continued.**Berkshire, No. 1 (Experiment III.).*

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1891.</b>								
May 26 to July 20, . . .	34.25	280.00	24.61	49.22	1:3.12	25.50	88.50	1.13
July 21 to Aug. 17, . . .	53.63	132.00	21.88	21.88	1:4.23	88.50	129.00	1.45
Aug. 18 to Sept. 30, . . .	149.82	219.00	33.97	33.97	1:4.91	129.00	203.00	1.72

*Total Amount of Feed consumed from May 26 to Sept. 30, 1891.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
237.70 pounds corn meal, . . .	201.31	\$3 68	\$0 72
631.00 quarts skim-milk, . . .	120.77	2 84	1 14
80.46 pounds wheat bran, . . .	70.01	0 93	0 45
105.07 pounds gluten meal, . . .	93.40	1 42	0 77
	485.49	\$8 87	\$3 08

	Pounds.
Live weight of animal at beginning of experiment, . . .	25.50
Live weight at time of killing, . . . . .	203.00
Live weight gained during experiment, . . . . .	177.50
Dressed weight at time of killing, . . . . .	163.50
Loss in weight by dressing, . . . . . 39½ pounds, or 19.46 per cent.	
Dressed weight gained during experiment, . . . . .	142.96

2.74 pounds of dry matter fed yielded 1 pound of live weight, and 3.40 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for production of 1 pound of dressed pork, 6.20 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing a loss of 30 per cent. of the manurial value of the feed, 4.69 cents.

*Detailed Statement of Third Experiment—Continued.**Berkshire, No. 2 (Experiment III).*

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1891.</b>								
May 26 to July 20, .	35.00	280.00	23.69	47.38	1:3.13	22.75	85.50	1.12
July 21 to Aug. 17, .	52.25	132.00	20.87	20.87	1:4.21	85.50	121.50	1.29
Aug. 18 to Sept. 30, .	134.41	219.00	26.26	26.26	1:4.86	121.50	192.00	1.60

*Total Amount of Feed consumed from May 26 to Sept. 30, 1891.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
221.66 pounds corn meal, . . .	187.72	\$3 44	\$0 68
631.00 quarts skim-milk, . . .	120.77	2 84	1 14
70.82 pounds wheat bran, . . .	61.62	0 81	0 40
94.51 pounds gluten meal, . . .	84.01	1 28	0 70
	454.12	\$8 37	\$2 92

	Pounds.
Live weight of animal at beginning of experiment, . . .	22.75
Live weight at time of killing, . . . . .	192.00
Live weight gained during experiment, . . . . .	169.25
Dressed weight at time of killing, . . . . .	160.00
Loss in weight by dressing, . . . . .	32 pounds, or 16.67 per cent.
Dressed weight gained during experiment, . . . . .	141.04

2.68 pounds of dry matter fed yielded 1 pound of live weight, and  
3.22 pounds of dry matter yielded 1 pound dressed weight.

Cost of feed for production of 1 pound of dressed pork, 5.93 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing  
a loss of 30 per cent. of the manurial value of the feed, 4.49 cents.



*Detailed Statement of Third Experiment — Continued.**Poland China, No. 1 (Experiment III).*

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1891.</b>								
May 12 to July 6, . . .	35.25	282.00	15.88	31.75	1:3.14	23.75	90.00	1.13
July 7 to July 27, . . .	41.88	105.00	15.63	15.63	1:4.23	90.00	122.00	1.52
July 28 to Sept. 7, . . .	131.31	202.00	27.78	27.78	1:4.89	122.00	195.25	1.74

*Total Amount of Feed consumed from May 12 to Sept. 7, 1891.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
208.44 pounds corn meal, . . .	176.53	\$3 23	\$0 64
589.00 quarts skim-milk, . . .	112.73	2 65	1 07
59.29 pounds wheat bran, . . .	51.59	0 68	0 33
75.16 pounds gluten meal, . . .	66.81	1 01	0 55
	407.66	\$7 57	\$2 59

	Pounds.
Live weight of animal at beginning of experiment, . . .	23.75
Live weight at time of killing, . . . . .	195.25
Live weight gained during experiment, . . . . .	171.50
Dressed weight at time of killing, . . . . .	155.50
Loss in weight by dressing, . . . . . 40 pounds, or 20.46 per cent	
Dressed weight gained during experiment, . . . . .	136.61

2.38 pounds dry matter fed yielded 1 pound live weight, and 2.98 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for production of 1 pound of dressed pork, 5.54 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing a loss of 30 per cent. of manurial value of feed, 4.22 cents.

*Detailed Statement of Third Experiment—Continued.**Poland China, No. 2 (Experiment III.).*

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-Milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1891.</b>								
May 12 to July 6, . . .	35.25	282.00	13.31	26.63	1:3.14	23.50	77.50	0.96
July 7 to Aug. 3, . . .	56.13	140.00	22.38	22.38	1:4.23	77.50	121.50	1.57
Aug. 4 to Sept. 7, . . .	112.93	167.00	25.41	25.41	1:4.91	121.50	180.00	1.67

*Total Amount of Feed consumed from May 12 to Sept. 7, 1891.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
204.31 pounds corn meal, . . .	173.03	\$3 17	\$0 62
589.00 quarts skim-milk, . . .	112.73	2 65	1 07
61.10 pounds wheat bran, . . .	53.16	0 70	0 34
74.42 pounds gluten meal, . . .	66.15	1 00	0 55
	405.07	\$7 52	\$2 58

	Pounds.
Live weight of animal at beginning of experiment, . . .	23.50
Live weight at time of killing, . . . . .	180.00
Live weight gained during experiment, . . . . .	156.50
Dressed weight at time of killing, . . . . .	143.50
Loss in weight by dressing, . . . 36½ pounds, or 20.28 per cent.	
Dressed weight gained during experiment, . . . . .	124.77

2.59 pounds of dry matter fed yielded 1 pound of live weight, and  
3.25 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for production of 1 pound of dressed pork, 6.03 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing  
a loss of 30 per cent. of manurial value of feed, 4.58 cents.

*Detailed Statement of Third Experiment — Continued.**Tamworth, No. 1 (Experiment III.).*

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at Close of Period (Pounds).	Gain in Weight per Day (Pounds).
<b>1891.</b>								
May 5 to June 8, . .	24.50	196.00	19.15	38.29	1:3.12	41.50	90.00	1.39
June 9 to July 6, . .	58.00	140.00	23.00	23.00	1:4.25	90.00	123.50	1.20
July 7 to Aug. 12, . .	127.57	174.00	31.09	31.09	1:4.94	123.50	184.50	1.65

*Total Amount of Feed consumed from May 5 to Aug. 12, 1891.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
210.07 pounds corn meal, . . .	177.91	\$3 26	\$0 64
510.00 quarts skim-milk, . . .	97.61	2 30	0 92
73.24 pounds wheat bran, . . .	63.73	0 84	0 41
92.38 pounds gluten meal, . . .	82.12	1 25	0 68
	421.37	\$7 65	\$2 65

	Pounds.
Live weight of animal at beginning of experiment, . . .	41.50
Live weight at time of killing, . . . . .	184.50
Live weight gained during experiment, . . . . .	143.00
Dressed weight at time of killing, . . . . .	163.00
Loss in weight by dressing, . . . . . 21½ pounds, or 11.65 per cent.	
Dressed weight gained during experiment, . . . . .	126.33

2.95 pounds of dry matter fed yielded 1 pound of live weight, and  
3.34 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for production of 1 pound of dressed pork, 6.06 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing  
a loss of 30 per cent. of manurial value of feed, 4.58 cents.

*Detailed Statement of Third Experiment—Continued.**Tamworth, No. 2 (Experiment III.).*

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Meal consumed (Pounds).	Nutritive Ratio of Feed.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day during Period (Pounds).
<b>1891.</b>								
May 5 to June 8, .	24.50	196.00	19.27	38.54	1:3.12	37.75	85.50	1.36
June 9 to July 6, .	59.69	140.00	24.69	24.69	1:4.26	85.50	122.50	1.32
July 7 to Aug. 12, .	122.38	174.00	28.50	28.50	1:4.92	122.50	179.50	1.54

*Total Amount of Feed consumed from May 5 to Aug. 12, 1891.*

	Dry Matter (Pounds).	Cost.	Manurial Value.
206.57 pounds corn meal, . . .	174.94	\$3 20	\$0 63
510.00 quarts skim-milk, . . .	97.61	2 30	0 92
72.46 pounds wheat bran, . . .	63.05	0 83	0 41
91.73 pounds gluten meal, . . .	81.54	1 24	0 68
	417.14	\$7 57	\$2 64

	Pounds.
Live weight of animal at beginning of experiment, . . .	37.75
Live weight at time of killing, . . . . .	179.50
Live weight gained during experiment, . . . . .	141.75
Dressed weight at time of killing, . . . . .	145.50
Loss in weight by dressing, . . . . .	.34 pounds, or 18.94 per cent.
Dressed weight gained during experiment, . . . . .	114.90

2.94 pounds of dry matter fed yielded 1 pound of live weight, and 3.63 pounds of dry matter yielded 1 pound of dressed weight.

Cost of feed for production of 1 pound of dressed pork, 6.59 cents.

Net cost of feed for production of 1 pound of dressed pork, allowing a loss of 30 per cent of manurial value of feed, 4.98 cents.

*Detailed Statement of Third Experiment—Concluded.**Summary of Gain in Weight (Experiment III.).*

SUMMER, 1891.	LIVE WEIGHT AT BE- GINNING (POUNDS.)		LIVE WEIGHT WHEN KILLED (POUNDS)		GAIN IN LIVE WEIGHT (POUNDS).	
	No. 1.	No. 2.	No. 1.	No. 2.	No. 1.	No. 2.
Small Yorkshires,	26.00	26.50	182.00	200.50	156.00	174.00
Poland Chinas, .	23.75	23.50	195.25	180.00	171.50	156.50
Berkshires, .	25.50	22.75	203.00	192.00	177.50	169.25
Tamworths, .	41.50	37.75	184.50	179.50	149.00	141.75

SUMMER, 1891.	NUMBER OF DAYS OF FEEDING.		GAIN IN LIVE WEIGHT PER DAY (POUNDS).	
	No. 1.	No. 2.	No. 1.	No. 2.
Small Yorkshires, . . .	133	156	1.17	1.12
Poland Chinas, . . .	119	119	1.44	1.32
Berkshires, . . .	128	128	1.39	1.32
Tamworths, . . .	100	100	1.43	1.42

*Fodder Analyses.**Corn Meal (Experiment I.).*

1890.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	12.39	247.80	—	—	1:9.70
Dry matter, . . .	87.61	1,752.20	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . .	1.80	36.00	—	—	
“ cellulose, . . .	1.80	36.00	12.24	84	
“ fat, . . .	5.01	100.20	76.15	76	
“ protein (nitrogenous matter), . . .	10.46	209.20	177.82	85	
Non-nitrogenous extract matter, . . .	80.93	1,618.60	1,521.48	94	
	100.00	2,000.00	1,787.69	—	

*Fodder Analyses—Continued.**Wheat Bran (Experiment I.).*

1890.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	11.52	230.40	-	-	1:3.71
Dry matter, . . . .	88.48	1,769.60	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . .	7.13	142.60	-	-	
“ cellulose, . . . .	10.63	212.60	42.52	20	
“ fat, . . . . .	5.62	112.40	89.92	80	
“ protein (nitrogenous matter), . . . . .	18.36	367.20	323.14	88	
Non-nitrogenous extract matter, . . . . .	58.26	1,165.20	932.16	80	
	100.00	2,000.00	1,387.74	-	

*Gluten Meal (Experiment I.).*

1890.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	8.48	169.60	-	-	1:2.22
Dry matter, . . . . .	91.52	1,830.40	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	0.76	15.20	-	-	
“ cellulose, . . . . .	0.68	13.60	4.62	34	
“ fat, . . . . .	11.14	222.80	169.33	76	
“ protein (nitrogenous matter), . . . . .	36.59	731.80	622.03	85	
Non-nitrogenous extract matter, . . . . .	50.83	1,016.60	955.60	94	
	100.00	2,000.00	1,751.58	-	

*Fodder Analyses — Continued.**Buttermilk (Experiment I.).*

1890.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	93.34	1,866.80	-	-	1 : 1.72
Dry matter, . . . . .	6.66	133.20	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	7.51	150.20	-	-	
" fat, . . . . .	4.80	96.00	96.00	100	
" protein (nitrogenous matter), . . . . .	36.64	732.80	732.80	100	
Non-nitrogenous extract matter, . . . . .	51.05	1,021.00	1,021.00	100	
	100.00	2,000.00	1,849.80	-	

*Skim-milk (Experiments I. and II.).*

1890.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C, . . .	89.78	1,795.60	-	-	1 : 2.13
Dry matter,. . . . .	10.22	204.40	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.85	137.00	-	-	
" fat, . . . . .	3.82	76.40	76.40	100	
" protein (nitrogenous matter), . . . . .	31.60	632.00	632.00	100	
Non-nitrogenous extract matter, . . . . .	57.73	1,155.60	1,155.60	100	
	100.00	2,000.00	1,864.00	-	

NOTE. — The analysis of the grain feed used during the second experiment is the same as of these articles stated in connection with the preceding corn-feeding experiment for the same period of time.

*Fodder Analyses — Continued.**Corn Meal (Experiment III.).*

1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.	
Moisture at 100° C., . . .	15.31	303.20	-	-	1: 9.23	
Dry matter, . . . . .	84.69	1,697.80	-	-		
	100.00	2,000.00	-	-		
<i>Analysis of Dry Matter.</i>						
Crude ash, . . . . .	1.72	34.40	-	-		
“ cellulose, . . . . .	2.17	43.40	20.83	48		
“ fat, . . . . .	4.84	96.80	82.28	85		
“ protein (nitrogenous matter), . . . . .	12.18	243.60	192.44	79		
Non-nitrogenous extract matter, . . . . .	79.09	1,581.80	1,550.16	98		
	100.00	2,000.00	1,845.71	-		

*Wheat Bran (Experiment III.).*

1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	12.99	259.80	—	—	1: 4.73
Dry matter, . . . . .	87.01	1,740.20	—	—	
	100.00	2,000.00	—	—	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.23	124.60	—	—	
“ cellulose, . . . . .	10.47	209.40	50.26	24	
“ fat, . . . . .	5.37	107.40	76.25	71	
“ protein (nitrogenous matter), . . . . .	16.16	323.20	252.10	78	
Non-nitrogenous extract matter, . . . . .	61.77	1,235.40	951.26	77	
	100.00	2,000.00	1,329.87	—	



*Fodder Analyses — Concluded.**Gluten Meal (Experiment III.).*

1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	11.11	222.20	-	-	1:2.66
Dry matter, . . . . .	88.89	1,777.80	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	1.65	33.00	-	-	
" cellulose, . . . . .	0.73	14.60	9.05	62	
" fat, . . . . .	9.22	184.40	156.74	85	
" protein (nitrogenous matter), . . . . .	33.34	666.80	526.77	79	
Non-nitrogenous extract matter, . . . . .	55.06	1,101.20	1,002.09	91	
	100.00	2,000.00	1,694.65	-	

*Skim-milk (Experiment III.).*

1891.

	Percentage Com- position.	Constituents (in Pounds) in a Ton of 2,000 Pounds.	Pounds Digesti- ble in a Ton of 2,000 Pounds.	Per Cent. of Di- gestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . . .	91.18	1,823.60	-	-	1:2.16
Dry matter, . . . . .	8.82	176.40	-	-	
	100.00	2,000.00	-	-	
<i>Analysis of Dry Matter.</i>					
Crude ash, . . . . .	6.80	136.00	-	-	
" fat, . . . . .	4.20	84.00	84.00	100	
" protein (nitrogenous matter), . . . . .	31.52	630.40	630.40	100	
Non-nitrogenous extract matter, . . . . .	57.48	1,149.60	1,149.60	100	
	100.00	2,000.00	1,864.00	-	

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**PART II.**  
**ON**  
**FIELD EXPERIMENTS**  
**AND**  
**OBSERVATIONS IN VEGETABLE PHYSIOLOGY**  
**AND**  
**PATHOLOGY.**

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1. **EFFECT OF DIFFERENT KINDS OF NITROGEN-CONTAINING MANURIAL SUBSTANCES ON THE YIELD OF RYE (FIELD A).**
  2. **EXPERIMENTS WITH PROMINENT VARIETIES OF GRASSES AND WITH GRASS MIXTURES, TO ASCERTAIN THEIR COMPARATIVE ECONOMICAL VALUE UNDER FAIRLY CORRESPONDING CIRCUMSTANCES (FIELD B).**
  3. **EXPERIMENTS WITH REPUTED FODDER CROPS MOSTLY NEW TO OUR LOCALITY, AND WITH A SERIES OF GARDEN CROPS TREATED WITH DIFFERENT MIXTURES OF COMMERCIAL FERTILIZING INGREDIENTS (FIELD C).**
  4. **EXPERIMENT WITH RAISING STOWELL'S EVERGREEN SWEET CORN FOR ENSILAGE (FIELD D).**
  5. **EXPERIMENTS WITH DIFFERENT COMMERCIAL PHOSPHATES, TO STUDY THE ECONOMY OF USING NATURAL PHOSPHATES OR ACIDULATED PHOSPHATES IN FARM PRACTICE (FIELD F).**
  6. **EXPERIMENTS WITH A WESTERN VARIETY OF DENT CORN, PRIDE OF THE NORTH, FOR ENSILAGE (FIELD G).**
  7. **EXPERIMENTS WITH GRASS LANDS (MEADOWS).**
  8. **REPORT ON GENERAL FARM WORK IN 1891.**
  9. **REPORT OF PROF. JAMES ELLIS HUMPHREY ON PLANT DISEASES, ETC., WITH OBSERVATIONS IN THE FIELD AND IN THE VEGETATION HOUSE.**
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1. **FIELD EXPERIMENT TO ASCERTAIN THE EFFECT OF DIFFERENT COMBINATIONS OF NITROGEN—I. E., SODIUM NITRATE, CHILI SALTPETRE, AMMONIUM SULPHATE AND NITROGEN-CONTAINING ORGANIC MATTER, UNDER OTHERWISE CORRESPONDING CIRCUMSTANCES—ON RYE (1891).**

*Field A.*

The well-authenticated and unbroken record of this field extends over more than twenty years. The systematic treatment of the soil, as far as modes of cultivation and of manuring are concerned, was introduced during the season of 1883–84. The subdivision of the entire area into eleven plats (one-eighth of an acre each) of a uniform size and shape, one hundred and thirty feet long and thirty feet wide, with an unoccupied and unmanured space of five feet in width between adjoining plats, has been retained unaltered since 1884. A detailed statement of the particular aim and general management of our experiments, as well as of the results obtained in that connection, from year to year forms a prominent part of our contemporary printed annual reports, to which I have to refer for details.

*The most conspicuous result of the field experiments carried on upon Field A during the years 1884 to 1888 consists in the very striking illustration of a marked deficiency of the soil on trial on available potash, as compared with other essential articles of plant food.*

*Since 1889 the main object of observations upon the same field has been to study the influence of both an entire exclusion of any additional nitrogen-containing manurial substance from the soil under cultivation, as well as of a definite additional supply of nitrogen in different forms of combination, on the character and yield of the crop selected for the trial. The treatment of the soil adopted in preceding years favored this new project for field observations.*

Several plats which for five preceding years did not receive any nitrogen compound for manurial purposes were retained

in that state, to study the effect of an entire exclusion of nitrogen-containing manurial substances on the crop under cultivation, while the remaining ones received as before a definite amount of nitrogen in the same form in which they had received it in preceding years: namely, either as sodium nitrate or as ammonium sulphate, or as organic nitrogenous matter in form of dried blood. A corresponding amount of available nitrogen was applied in all these cases.

Aside from the difference regarding the nitrogen supply, all plats were treated alike. They each received without an exception a corresponding amount of available phosphoric acid and of potassium oxide. The phosphoric acid was supplied, in form of dissolved bone-black, and the potassium oxide either in form of muriate of potash or of potash-magnesia sulphate. From 120 to 130 pounds of potassium oxide, from 80 to 85 pounds of available phosphoric acid and from 40 to 50 pounds of available nitrogen were supplied per acre.

One plat marked 0 received its main supply of phosphoric acid, potassium oxide and nitrogen in form of barn-yard manure; the latter was carefully analyzed before being applied, to determine the amount required to secure, as far as practicable, the desired corresponding proportion of essential fertilizing constituents. The deficiency in potassium oxide and phosphoric acid was supplied by potash-magnesia sulphate and dissolved bone-black. The fertilizer for this plat consisted of 800 pounds of barn-yard manure, 32 pounds of potash-magnesia sulphate and 18 pounds of dissolved bone-black.

The mechanical preparation of the soil, the incorporation of the manurial substances, — the general character of the latter being the same, — the seeding, cultivating and harvesting were carried on year after year in a like manner, and as far as practicable on the same day in case of every plat during the same year.

This course in the general management of the experiment has been followed thus far for three successive years — 1889, 1890 and 1891 — in connection with different crops: —

Corn (maize), in 1889 (see seventh annual report); oats,

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in 1890 (see eighth annual report); rye, in 1891 (see ninth annual report).

The following tabular statement shows the annual application and special distribution of the manurial substances with reference to each plat since 1889. The fertilizers were in every case applied broadcast as early as circumstances permitted. They were slightly harrowed under before the seed was planted in rows by a seed drill. Each plat received the same amount of seed.

NUMBER OF PLAT.	Annual Supply of Manurial Substances.
Plat 0, .	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black.
Plat 1, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 2, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 3, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 4, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 5, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 6, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 7, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 8, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 9, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 10, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).

*1891.* — The soil of the field being brought by ploughing and harrowing into a good mechanical condition for planting, the entire area was seeded with winter rye Sept. 5, 1890. Each plat received five and one-half pounds of rye in drills two feet apart. The second largest plate was used in the seeding machine.

The young plants appeared above ground October 1. The growth upon Plat 6 and on 8 in particular presented

soon after a yellowish-green appearance; otherwise the crop promised well.

The late winter season was somewhat unfavorable to winter crops, — a fact noticed quite generally in our vicinity on grass lands. The rye crop showed signs of winter-killing; the growth upon Plat 2 had apparently suffered more than that on any other plat. The following tabular record shows the rate of growth upon the different plats at different periods of the season, — May 12 to June 16:—

	May 12.	May 19.	May 27.	June 2.	June 10.	June 16.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Plat 0, . . .	19	26	42	61	65	66
Plat 1, . . .	21	27	44	60	66	66
Plat 2, . . .	21	27	44	60	65	66
Plat 3, . . .	21	27	46	63	67	67
Plat 4, . . .	17	24	40	58	65	65
Plat 5, . . .	19	23	40	59	64	66
Plat 6, . . .	8	16	32	50	64	65
Plat 7, . . .	20	26	46	60	68	68
Plat 8, . . .	6	14	30	44	55	58
Plat 9, . . .	19	28	40	61	66	66
Plat 10, . . .	22	27	47	62	67	67

The differences noticeable in the above table regarding the rate of growth upon different plats are not less marked than were the variations in the color of the vegetation upon different plats at different stages of the season. The growth upon plats 4, 7, 10, and in particular 9, was of a light-green color; while upon plats 1 and 2 it was of a marked deep-green shade. This feature in the appearance of the vegetation over the entire area was quite marked during the entire season until the crop began to mature. Plats 4, 7 and 9 turned yellow, while plats 1, 2, 5, 6 and 8 were still green (July 9). The entire crop was cut July 16, and carried into the barn July 18. The subsequent tables show the difference in moisture of the crop from different plats when carried into the barn, as compared with a more uniform condition in that direction after two months' storing in the barn:—

	Weight when Harvested (July 18, 1891).	Weight when Threshed (Sept. 22, 1891).	Loss of Moisture.
	Pounds.	Pounds.	Per Cent.
Plat 0, . . . . .	695	470	32.37
Plat 1, . . . . .	790	570	27.85
Plat 2, . . . . .	700	525	25.00
Plat 3, . . . . .	605	475	21.49
Plat 4, . . . . .	490	390	20.41
Plat 5, . . . . .	660	530	19.70
Plat 6, . . . . .	505	400	20.79
Plat 7, . . . . .	495	450	9.09
Plat 8, . . . . .	—	—	—
Plat 9, . . . . .	495	425	14.14
Plat 10, . . . . .	520	425	18.27

Plat 8 is excluded from the statement on account of a partial destruction of the crop by insects. The total yield of straw and grain obtained from different plats varies from 390 to 570 pounds in weight.

The relation of the grain to the straw and chaff will be found in the statement below :—

	Grain and Straw.	Grain.	Straw and Chaff.	Percentage of Grain.	Percentage of Straw and Chaff.
	Pounds.	Pounds.	Pounds.		
Plat 0, . . . . .	470	142	328	30.21	69.79
Plat 1, . . . . .	570	154	416	27.02	72.98
Plat 2, . . . . .	525	134	391	25.52	74.48
Plat 3, . . . . .	475	130	345	27.37	72.63
Plat 4, . . . . .	390	107	283	27.44	72.56
Plat 5, . . . . .	530	145	385	27.36	72.64
Plat 6, . . . . .	400	102	298	25.50	74.50
Plat 7, . . . . .	450	109	341	24.22	75.78
Plat 8, . . . . .	—	—	—	—	—
Plat 9, . . . . .	425	109	316	25.65	74.35
Plat 10, . . . . .	425	125	300	29.41	70.59
	4,875	1,303	3,572	—	—

The yield of the grain for the entire field in case of the air-dry crop averages 26.72 per cent. and that of the straw and chaff 73.28 per cent. The yield of the grain upon different plats varies from 102 pounds to 154 pounds. Plat

2 differs in yield from Plat 1, probably on account of a more serious degree of winter-killing, as has been stated on a previous page. Plat 6 shows still the serious influence of several years' fallow (1885 to 1888), without the application of manure and without the cultivation of a crop (black fallow), on the productiveness of the soil thus treated. The low yield of grain (107 to 109 pounds) upon plats 4, 7 and 9, which did not receive any nitrogen-containing manurial matter, is a very significant result. The belief in the beneficial influence of a liberal supply of nitrogen on the quantity and the quality of grain crops is evidently well sustained by the results of the above-described experiment.



## Summary of Three Years' Observations upon Field A (1889-91).

Number of Plat.	MANURIAL MATTER APPLIED.	1889.		1890.			1891.			
		Yield of Dry Rooder Corn.	Crop (Pounds).	Percentage of Grain.	Percentage of Straw and Chaff.	Crop (Pounds).	Percentage of Grain.	Percentage of Straw and Chaff.	Yield of Grain (Pounds).	Yield of Straw (Pounds).
Plat 0.	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black,	Pounds.	315	38.10	31.90	470	80.21	66.79	142	328
Plat 1.	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	648	362	35.36	64.34	570	27.02	72.98	154	416
Plat 2.	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	577	365	35.34	64.36	525	25.52	74.48	134	391
Plat 3.	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	618	345	33.62	66.38	475	27.37	72.63	130	345
Plat 4.	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	381	260	34.61	63.39	390	27.44	72.56	107	283
Plat 5.	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	488	340	39.20	60.80	530	27.36	72.64	145	385
Plat 6.	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	542	335	32.21	67.79	400	25.60	74.50	102	298
Plat 7.	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	526	320	34.40	65.60	450	24.32	75.78	109	341
Plat 8.	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	359	220	26.82	73.18	-	-	-	-	-
Plat 9.	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	476	290	34.83	65.17	425	25.65	74.35	109	315
Plat 10.	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	640	395	35.44	64.56	425	22.41	70.59	125	300

## FIELD "A," 1891.

10	43 lbs. Dried Blood. <del>48½ lbs. Potash Magnesia Sul.</del> 50 lbs. Dis. Bone Black.	SCALE, 4 RODS TO 1 INCH.
9	25 lbs. Muriate of Potash. <del>450 lbs. Dis. Bone Black.</del>	
8	22½ lbs. Sulphate Ammonia. <del>25 lbs. Muriate of Potash.</del> 50 lbs. Dis. Bone Black.	
7	25 lbs. Muriate of Potash. 50 lbs. Dis. Bone Black.	
6	22½ lbs. Sulphate Ammonia. <del>25 lbs. Muriate of Potash.</del> 50 lbs. Dis. Bone Black.	
5	22½ lbs. Sulphate Ammonia. <del>48½ lbs. Potash Magnesia Sul.</del> 50 lbs. Dis. Bone Black..	
4	25 lbs. Muriate Potash. 50 lbs. Dis. Bone Black.	
3	43 lbs. Dried Blood. <del>25 lbs. Muriate of Potash.</del> 50 lbs. Dis. Bone Black.	
2	29 lbs. Nitrate of Soda. <del>48½ lbs. Potash Magnesia Sul.</del> 50 lbs. Dis Bone Black.	
1	29 lbs. Nitrate of Soda. <del>25 lbs. Muriate of Potash.</del> 50 lbs. Dis. Bone Black.	
0	800 lbs. Barnyard Manure. <del>32 lbs. Potash Magnesia Sul.</del> 18 lbs. Dis. Bone Black	RYE PLATS.

2. FIELD EXPERIMENT WITH PROMINENT VARIETIES OF GRASSES, TO STUDY THEIR COMPOSITION UNDER FAIRLY CORRESPONDING CONDITIONS, AS FAR AS SOIL AND MANURE ARE CONCERNED, AND TO COMPARE THEIR ECONOMICAL VALUE WHEN RAISED BY THEMSELVES AS WELL AS IN CASE OF MIXTURES (1891).

*Field B.*

This field occupies an area of one and seven-tenths acres, and runs from north to south, nearly on a level. The soil consists of a somewhat sandy loam of several feet in depth. The systematic treatment of the area was inaugurated in 1884, when the present subdivision into eleven plats was first introduced. The plats are 175 feet long and 33 feet wide (5,775 square feet, or two-fifteenths of an acre), of a uniform shape, running from east to west, with a space of five feet between adjoining plats. The numbering begins at the north end with 11, and closes at the south end with 21. From 1884 to 1889 every alternate plat received annually the same kind and the same amount of fertilizer, — 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre. Plats 11, 13, 15, 19 and 21 were annually manured as stated, and plats 12, 14, 16, 18 and 20 received no manurial matter of any description during that period (1884 to 1889). The space of five feet left between the different succeeding plats has been kept clean from any growth by a constant use of the cultivator, and received at no time any kind of manure.

The details of the work carried on upon Field B have been thus far reported from year to year in our annual reports. The chemical analyses of the crops raised upon this field, on account of the amount of work involved, have been quite frequently published in later bulletins or in annual reports of the succeeding year.

A material change in the above-stated management of the field was made in 1889, with reference to the previously unmanured plats, 12, 14, 16, 18 and 20; they were subse-

quently annually manured in exactly the same manner as the remaining plats, receiving per acre 600 pounds of fine-ground bone and 200 pounds of muriate of potash. The character of the crops raised upon the various plats since 1888 to date may be seen from the following tabular statement:—

PLATS.	1888.	1889.	1890.	1891.
Plat 11 (fertilized), .	{ Kentucky blue-grass ( <i>Poa pratensis</i> ), . . . .	{ Kentucky blue-grass, . . . .	{ Kentucky blue-grass, sown Sept. 24, 1889, . . . .	{ Kentucky blue-grass, sown Sept. 24, 1889, . . . .
Plat 12 (unfertilized), .	{ Kentucky blue-grass, . . . .	{ Kentucky blue-grass, . . . .	{ Kentucky blue-grass, sown Sept. 24, 1889, . . . .	{ Kentucky blue-grass, sown Sept. 24, 1889, . . . .
Plat 13 (fertilized), .	{ Italian rye-grass, . . . .	{ Red-cob ensilage corn, . . . .	{ Red top, sown Sept. 24, 1889, . . . .	{ Italian rye-grass, north, sown Sept. 20, 1889, . . . .
Plat 14 (unfertilized), .	{ Italian rye-grass, . . . .	{ Red-cob ensilage corn, . . . .	{ Red top, sown Sept. 24, 1889, . . . .	{ Italian rye-grass, south, sown Sept. 20, 1889, . . . .
Plat 15 (fertilized), .	{ Soja bean ( <i>Soja hispida</i> ), . . . .	{ Bokhara clover ( <i>Medicago alba</i> ), . . . .	{ Bokhara clover, sown May 8, 1889, . . . .	{ English rye-grass and red top, sown Sept. 28, 1889, . . . .
Plat 16 (unfertilized), .	{ Soja bean, . . . .	{ Bokhara clover, . . . .	{ Sainfoin, sown May 8, 1889, . . . .	{ Herds grass and red top, sown April 28, 1890, . . . .
Plat 17 (fertilized), .	{ Meadow fescue, . . . .	{ Sainfoin, . . . .	{ Rhode Island bent ( <i>Agrostis alba</i> ), sown Sept. 26, 1889, . . . .	{ Italian rye-grass and red top, sown April 23, 1890, . . . .
Plat 18 (unfertilized), .	{ Aislke clover, . . . .	{ Meadow fescue, . . . .	{ Meadow fescue, sown September, 1887, . . . .	{ Meadow fescue, sown September, 1887, . . . .
Plat 19 (fertilized), .	{ Medium red clover, . . . .	{ Red-cob ensilage corn, . . . .	{ Meadow fescue, sown September, 1889, . . . .	{ Meadow fescue, sown Sept. 29, 1890, . . . .
Plat 20 (unfertilized), .	{ Aislke clover, . . . .	{ Aislke clover, . . . .	{ Herds grass, sown September, 1889, . . . .	{ Herds grass, sown Sept. 28, 1889, . . . .
Plat 21 (fertilized), .	{ Medium red clover, . . . .	{ Medium red clover, . . . .	{ Red top and herds grass mixed, sown September, 1889, . . . .	{ Herds grass and red top, sown Sept. 29, 1890, . . . .
Plat 22 (unfertilized), .	{ Mammoth red clover, . . . .	{ Red-cob ensilage corn, . . . .	{ Mammoth red clover, . . . .	{ Meadow fescue and red top, sown Sept. 29, 1890, . . . .
Plat 23 (fertilized), .	{ Alfalfa, . . . .	{ Corn (variety, Clark), . . . .	{ Meadow fescue and herds grass, mixed, sown September, 1889, . . . .	{ Meadow fescue and red top, sown Sept. 29, 1890, . . . .

1891.—Previous to the year 1891 other crops than grasses have been cultivated upon some plats at times. Of late none but single grasses or mixtures of reputed grasses have been planted. The single grasses are raised as in previous years in rows two feet apart; grass mixtures are seeded down broadcast. The manure in case of single grasses is applied by hand between the rows, and is subsequently slightly ploughed in by means of a cultivator; in case of grass mixtures the manure is applied as top dressing early in the spring. In both cases the first manure is applied broadcast and ploughed under before seeding down the grass.

Plat 11, Kentucky blue-grass (*Poa pratensis*), sown Sept. 24, 1889, in rows. The grass looked well in the spring; the growth between the rows was removed with the cultivator and the hoe, to secure as far as practicable a clean crop. The grass began to bloom June 5, when 27 inches high; it was cut when the seed began freely to set (June 17).

Plat 12, Kentucky blue-grass (*Poa pratensis*), sown Sept. 24, 1889. The grass on this plat showed signs of winter-killing. The crop was cut June 17. The yield of both plats, 11 and 12, amounted to 260 pounds of hay (975 pounds per acre) when removed to the barn. This plat (12) was ploughed July 8, 1891, the sod thoroughly cut up with a wheel harrow, properly harrowed and seeded down Sept. 18, 1891, with a mixture of four pounds each of Kentucky blue-grass and red top. The grass was well above ground Sept. 28, 1891.

Plat 13, English rye-grass (*Lolium perenne*) and Italian rye-grass (*Lolium Italicum*), each occupying one-half of the plat. Both were sown in rows Sept. 29, 1890. The Italian rye-grass was in better condition at the beginning of the spring than the English rye-grass. The latter had suffered in a considerable degree from winter-killing. The winter-killed spots were re-seeded at an early date. Both grasses bloomed fairly June 18; they were cut June 24. The first cut of hay amounted to one hundred pounds in each case (1,500 pounds per acre). The second cut of the English rye-grass yielded 120 pounds (1,800 pounds per acre) August 18, while the Italian rye-grass yielded 90 pounds (1,350 pounds per acre).

Plat 14, a mixture of English rye-grass and of red top, equal weights, sown broadcast Sept. 29, 1890. The crop was cut June 24; red top was not yet in bloom. The first crop amounted to 355 pounds of hay (2,662 pounds per acre); the second cut, August 31, yielded 90 pounds of hay (675 pounds per acre).

Plat 15, herds grass (*Phleum pratense*) and red top (*Agrostis vulgaris*), sown broadcast April 23, 1890. The crop was to such an extent infested with shepherd's purse that no record of yield was kept. The growth upon the plat was mowed whenever the weeds showed themselves above the grasses, to ascertain whether a repeated cutting during the first season will free the plat from that particular trouble.

Plat 16, Italian rye-grass and red top, sown broadcast April 23, 1890. The growth upon this plat suffered from the same causes as the preceding plat, — namely, from shepherd's purse, — and from the seeding down of grasses during spring time. The seeding down of grass lands in the spring is known to be an objectionable practice. Our experiment is made to furnish an illustration in that direction, and also to point out if possible some remedies.

Plat 17, meadow fescue (*Festuca pratensis*), sown in rows two feet apart, Sept. 25, 1887. The crop looked healthy every way throughout the season. It was in bloom June 15, when 38 inches high. The first cut, June 16, amounted to 450 pounds of hay (3,375 pounds per acre); and the second cut, September 1, to 140 pounds (1,050 pounds per acre).

Plat 18, meadow fescue, sown in rows two feet apart, Sept. 29, 1890. The grass looked healthy and vigorous during the entire period of growth. It bloomed June 20 and was cut June 25. The first cut yielded 190 pounds of hay (1,425 pounds per acre); and the second cut, September 1, yielded 170 pounds (1,275 pounds per acre).

Plat 19, herds grass (*Phleum pratense*), sown in rows two feet apart, Sept. 25, 1889. The growth looked well throughout the season; it began to bloom June 25 and was cut July 1. The hay obtained weighed 630 pounds (4,725 pounds per acre).

Plat 20, mixture of herds grass and red top, sown broadcast Sept. 29, 1890. The herds grass was in bloom June 30; red top showed no flower at that time. The crop was cut July 1, and yielded 430 pounds of hay (3,225 pounds per acre).

Plat 21, meadow fescue (*Festuca pratensis*) and red top (*Agrostis vulgaris*), sown broadcast Sept. 29, 1890. The growth did not correspond to the seeds named. The first cut yielded, June 25, 650 pounds of hay (4,875 pounds per acre). The plat was ploughed, and the soil after thorough mechanical preparation was re-seeded September 18 with a mixture of four pounds of meadow fescue and four pounds of red top.

From the previous statements it will be seen that our present observation upon this field is confined to the following grasses and grass mixtures:—

Kentucky blue-grass.

English rye-grass.

Italian rye-grass.

Red top.

Herds grass.

Meadow fescue.

Kentucky blue-grass and red top.

English rye-grass and red top.

Italian rye-grass and red top.

Red top and herds grass.

Herds grass and meadow fescue.



FIELD "B," 1891.

11	Kentucky Blue Grass.
12	Kentucky Blue Grass.
13	English Rye Grass. Italian Rye Grass.
14	English Rye Grass and Red Top.
15	Herds Grass and Red Top.
16	Italian Rye Grass and Red Top.
17	Meadow Fescue.
18	Meadow Fescue.
19	Herdsgrass.
20	Herdsgrass and Red Top.
21	Meadow Fescue and Red Top.

### 3. EXPERIMENTS WITH FIELD AND GARDEN CROPS (1891).

#### *Field C.*

The area occupied by this piece of land is 328 feet long and 183 feet wide (60,024 square feet). The field is divided into two parts, running from west to east, making thus a north and south division, each 328 feet long and 90 feet wide, with three feet of unoccupied space between them. The soil consists of a good light loam, several feet in thickness. The manure annually applied during preceding years (1884–90) to the entire area consisted of 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre. The north division had been used for years for the raising of miscellaneous farm and garden crops, for the purpose of studying their adaptation to our climate. Upon the south division during the same period grain and leguminous crops were raised alternately, to serve as fodder.

1891.—Both divisions were ploughed during the preceding autumn, and again in the spring. The *north division* was manured at an early date with bone and potash, as in preceding years,—600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre. The fertilizer was applied broadcast, and subsequently ploughed in before harrowing and seeding.

The *south division* was subdivided into five plats of a uniform size and shape, with an unoccupied and unmanured space of from four to five feet between adjoining plats. Each plat running across the south division from north to south covered an area of sixty-two by eighty-eight feet. Each plat received a separate distinct mixture of fertilizing substances, to test the effect on the quality and quantity of different kinds of garden crops.

#### 1. *North Division, Field and Forage Crops.*

The field was prepared and manured as above stated, and served as in preceding years for the cultivation of a variety of field crops. The work was instituted for the purpose of studying the acclimatization of a series of more or less

reputed farm plants new to our section of the country, and also to serve as an object lesson to our visitors, regarding their general characteristics. The benefit derived from this practical illustration of our possibilities in the choice of valuable additions to our field crops has been so manifest during preceding years that it will receive increased attention on our part in the future. Some of the plants here cultivated during previous seasons have already been introduced into our farm industry on a sufficiently extensive scale to enable us to form a decided opinion regarding their special local economical value. Foremost among them are some fodder crops, Southern cow-pea, serradella, some vetches, and black and white soja bean. Successful feeding experiments with green vetch and oats and with green soja bean, as well as with a mixed ensilage of soja bean and green fodder corn, have been already noted in our preceding report (eighth). The satisfactory results of preceding years were fully confirmed during the late summer season. A detailed description of this experiment may be found in this report, under the heading, "Summer Feeding Experiment with Milch Cows," page 59.

Statement of crops raised upon the north division of Field C:—

White soja bean (*Soja hispida*), four rows. The seed was raised upon the station grounds in 1890. It was sown in rows three feet and three inches apart, May 18; the young plants appeared above ground May 30, and began to bloom during the middle of July. The lower leaves began to dry up September 4. The crop was pulled to collect the seed September 25.

Black soja bean, four rows. This variety is of a lighter-green color, and seems to be somewhat more vigorous than the former. It is still green when the white variety has turned yellow. We have raised for several years, successfully, large crops of both varieties of soja bean, and consider them for our locality a most valuable addition to our forage crops.

Serradella (*Ornithopus sativus*), eight rows, three feet three inches apart. Sown May 14; began to bloom July 20; appeared somewhat affected by blight September 3, but

recovered from this trouble towards the close of September, and was in a healthy condition by October 6. The crop was light, compared with results of previous years; it resisted cold spells to an exceptional degree, being still green October 23. The serradella has furnished us in previous years an exceptionally valuable green fodder, at the rate of from ten to eleven tons of green feed per acre.

Bokhara clover (*Melilotus alba*), four rows, three feet three inches apart. Sown May 23, and had reached a height of over three feet June 16, when it was cut, not yet in bloom. The second growth was much lighter than the first, and was blooming August 7. The plants were not affected by frost October 13. The Bokhara clover furnishes a luxuriant growth, and has a pleasant aromatic odor. It deserves a trial as ensilage, when cut before blooming.

Spring vetch (*Vicia sativa*), four rows, three feet three inches apart. The seed was sown May 14. The young plants appeared above ground May 23, and began to bloom July 2. The crop was cut when beginning to dry, August 17. This plant has a well-established reputation as an excellent fodder crop for dairy purposes. We have for several years raised, very satisfactorily, a mixed crop of vetch and oats, to serve as green fodder for our cows. The yield is liberal, and makes a good hay when properly dried.

Winter vetch, four rows. This variety proved to be somewhat later in blooming, otherwise it showed no particular difference from the former.

Kidney vetch, four rows, two feet apart. The seed was sown May 14; the young plants were noticed above ground May 23. The growth was very slow, the plants measuring only three inches in height September 19. They failed to develop blossoms.

Sainfoin (*Onobrychis sativa*), four rows, three feet three inches apart. Sown May 23, 1890; began blooming May 25. The growth was twenty inches high and almost through blooming when cut, July 17. The second crop was light. Frosts during October did not affect the foliage. Several years' trial shows that the growth is frequently seriously winter-killed.

Yellow trefoil, four rows, three feet three inches apart.

Sown May 14; was up May 27. The growth was very slow, being about four inches high September 19. The first blossoms appeared sparingly October 6. The plants withstood less successfully the October frosts, as compared with some of the previously described crops.

Yellow lupine (*Lupinus luteus*), four rows, three feet three inches apart. Sown May 15; came up May 25. The plants were ten inches high July 14; began blooming when sixteen inches high, July 20. They reached the height of two feet September 18, when an abundance of seed-pods were formed.

White lupine (*Lupinus alba*), four rows, three feet three inches apart. Sown May 15; came up May 23; began to bloom July 4, when twenty-eight inches high. The plants were thirty-eight inches high July 21, and still continued to grow. This crop when in its succulent state (July) has served in preceding years in a superior degree as efficient green manure for winter crops and exhausted grass lands.

Forest pea (*Lathyrus sylvestris*), four rows, two feet six inches apart. Sown May 15; the plants came up sparingly June 10. The growth was very slow, being only four inches high September 19. Frosts did not affect it as late as October 13. This plant is new as a forage crop in Germany and England. Our seed was imported from the latter place, and not the best kind. As it is a biennial plant, another year is needed to form an opinion regarding its economical value.

Common buckwheat (*Fagopyrum esculentum*), four rows, two feet apart. Sown May 14. It began to bloom June 20, and was cut for fodder when the seeds began to set, July 27.

Japanese buckwheat, four rows, two feet apart. Sown May 14; blossomed June 23, and was cut for fodder, like the former variety, July 27. The plants are somewhat more hardy than the common buckwheat.

Silver-hull buckwheat; four rows. Sown May 14; bloomed June 20, and showed a liberal formation of seed-pods July 27, when the crop was cut. A second lot, seeded down June 25, began to bloom July 21, and had finished blossoming August 26. In regard to the weight of

the crop harvested, the buckwheats ranked in this order: silver-hull, Japanese, common variety.

*Stachys tubers (Stachys affinis)*, little tubers sent on by the Department of Agriculture in Washington, were planted (one row) April 21. They came up May 1; had reached a growth of nine and one-half inches September 19, when suckers came out. Frost did not affect the foliage before October 28. The tubers were left in the ground for observations during the coming year. The tubers are considered a substitute for potatoes in the south of France.

Chinese potato bulblets, sent on for trial as a potato substitute by the United States Department of Agriculture. They were planted April 21, two feet apart in the row; came up May 30, and were from two to three inches high July 14. The plants send out runners from eighteen to twenty inches in length. Leaves suffered from frost October 1. The bulblets were left in the ground for observations during the coming year.

Prickly comfrey (*Symphytum officinale*), one row. The roots for planting were kindly presented by Col. J. D. W. French, and were put in the ground Oct. 11, 1890, two feet apart in the row. They produced a luxuriant growth during the late spring; began to blossom June 5, and reached a height of twenty inches, with numerous highly foliaceous branches. The blossoms were removed, to prevent a seeding out. The plants kept green until the middle of October.

English rye-grass (*Lolium perenne*), three rows. This variety of grass has been raised for a number of years on various fields of the station farm, to ascertain its degree of resistance to the influence of our winter climate. After repeated trials, it is safe to say that it is in an exceptional degree liable to winter-killing in our locality. One-half of the field was winter-killed during the previous winter.

Campbell's spring wheat, three rows, two feet apart. Sown May 4; appeared above ground May 22, and was ripe for cutting August 22. It made a rather light growth.

Winter wheat, twelve varieties, sent on from London, Eng. (Nos. 1-12 below). Each variety occupied five feet in the row, with one foot of space between them. They

were sown Sept. 30, 1890. In connection with the English samples were sown two samples of winter wheat sent on by the United States Department of Agriculture (Nos. 13 and 14). Names of varieties: 1. Carter's Millers' Delight; 2. Carter's Stand Up; 3. Carter's Earliest of All; 4. Carter's Anglo-Canadian; 5. Carter's Pride of the Market; 6. Carter's Pearl; 7. Carter's Bird Proof; 8. Carter's Prince of Wales; 9. Carter's Queen; 10. Carter's Hundred Fold; 11. Carter's Flour Ball; 12. Carter's Holborn Wonder; 13. Hybride Dattel; 14. Hybride Larned. No. 4 was badly winter-killed; Nos. 8, 9, 10 and 11 suffered somewhat less from winter-killing; Nos. 1 and 2 were both in good condition. Most of the varieties began to blossom June 21. Nos. 1 and 3 matured first. They were cut July 21. Nos. 2, 5, 7, 8 and 14 were cut August 5, Nos. 6 and 11 were cut August 8, and Nos. 4 and 13 were cut August 12. Our last year's experience with winter wheat has been discouraging, on account of serious damage by frost in all parts of the field.

Kansas king corn, one row. Sown with seed sent on for trial May 20. It was above ground May 30, reached nine feet in height September 19, and was killed by frost October 13, without being matured.

Jerusalem corn, one row, on trial. Sown May 20; appeared above ground May 30; was five inches high July 14; blossomed September 19, when sixty-two inches high, and was killed by frost October 13, when still immature.

Sugar beets, five European varieties. The seeds were received from the United States Department of Agriculture for trial. Five rows of each variety were planted May 20. The young plants were above ground May 27; they were thinned out (from six to eight inches apart) June 22. The crop looked well until the beginning of September, when a brown fungous growth appeared on the leaves. The roots were harvested October 19. They yielded as follows:—

	Pounds.
Florimond Desprez's Richest, . . . . .	710
Bulteau Desprez's Richest, . . . . .	690
Dippe's Kleinwanzleben, . . . . .	600
Dippe's Vilmorin, . . . . .	620
Simon Le Grand's White Improved, . . . . .	550

*Analysis of Sugar Beet Roots, raised 1891.*

VARIETY.	Date of Test.	Average Weight of Beets (Grams).	Moisture at 100° C.	Temperature of Juice.	Degrees, by Brix.	Sugar in Juice, by Fehling's Test (Per Cent.).
Florimond Desprez's Richest, . . .	Dec. 3, .	508.06	85.87	18° C.	14.3	13.35
Bulteau Desprez's Richest, . . .	Dec. 2, .	498.10	84.54	17° C.	14.4	13.06
Dippe's Kleinwanzleben, . . .	Dec. 2, .	463.52	83.59	19° C.	15.2	13.88
Dippe's Vilmorin, . . .	Dec. 1, .	522.00	83.75	19.5° C.	15.6	12.54
Simon Le Grand's White Improved, .	Dec. 3, .	435.22	81.49	20° C.	16.8	15.67

*2. South Division, Garden Crops.\**

This part of Field C, 328 feet long and 88 feet wide (28,864 square feet), was subdivided as above stated during the spring of 1891 into five plats of a uniform size and shape (88 feet by 62 feet, one-eighth of an acre), running from north to south across the main field. These were separated from each other by an unmanured space of from four to five feet in width. The soil was several feet deep, and consisted of a rather light loam in a good state of cultivation as far as its mechanical condition is concerned. No other manurial matter but fine-ground bone and muriate of potash, 600 pounds of the former and 200 pounds of the latter per acre, was used before 1891. The field slopes very gently from west to east. The plats were numbered 1, 2, 3, 4, 5, beginning on the east end of the field. Each plat received, spring of 1891, a manurial mixture of its own as fertilizer. The difference of the fertilizers applied consisted essentially in the circumstance that nitrogen and potash were used in several of them in different forms. All plats received practically the same quantity of nitrogen, potash and phosphoric acid, and every one of them received its phosphoric acid addition in the same form, namely, dissolved bone-black. Some plats received their nitrogen supply in the form of organic animal matter, dried blood; others received their nitrogen in the form of sodium nitrate, Chili saltpetre; others in the form of ammonium sulphate. Some plats received their



potash in the form of muriate of potash and others in the form of the highest grade of potassium sulphate (in our market 95 per cent. purity). The subsequent tabular statement shows the quantities of the manurial substances applied to different plats : —

Plat 1, . . .	{ 75 pounds dried blood. 30 pounds muriate of potash. 40 pounds dissolved bone-black.
Plat 2, . . .	{ 47 pounds nitrate of soda. 30 pounds muriate of potash. 40 pounds dissolved bone-black.
Plat 3, . . .	{ 38 pounds sulphate of ammonia. 30 pounds muriate of potash. 40 pounds dissolved bone-black.
Plat 4, . . .	{ 47 pounds nitrate of soda. 30 pounds high-grade sulphate of potash. 40 pounds dissolved bone-black.
Plat 5, . . .	{ 38 pounds sulphate of ammonia. 30 pounds high-grade sulphate of potash. 40 pounds dissolved bone-black.
Per acre: Phosphoric acid, . . . . .	50.4
Nitrogen, . . . . .	60.0
Potassium oxide, . . . . .	120.0

The different fertilizers were applied broadcast, and subsequently slightly ploughed under in all cases on the same day (April 22, 1891). All plats were planted in the same order with the same kind of garden crops (eight). Every plat was either planted with young plants or was sown with the seed, as circumstances dictated, each kind on the same day and in the same manner. The young plants used for the experiment were raised under corresponding conditions from seed in the hot-bed. The seeds used were in several cases sent on for trial. The different kinds of garden crops were arranged in the following order, beginning on the east side of each plat : —

Lettuce, White Tennis Ball, one row.

Spinach, Long Standing and Bloomingdale, one row each.

Beets, Egyptian and Dewings, one row each, or two of a kind.

Celery, White Plume, one row.

Kohlrabi, two rows.

Cabbage, Red Dutch and several white varieties, three rows in all.

Tomatoes, Boston Market, two rows.

Potatoes, Beauty of Hebron, five rows.

Spinach, beets and potatoes were raised from seeds upon the different plats. Lettuce, celery, kohlrabi, cabbage and tomatoes were sown in a hot-bed and subsequently transferred when of suitable size, each kind for all plats on the same day, as will be found farther on. All crops were kept clean during the growing season by a timely use of the cultivator and the hoe.

Lettuce, White Tennis Ball, set out May 1. The growth was in the beginning slow, on account of cold and dry weather, but subsequently recovered rapidly and produced a good yield, judging from the general appearance of the crop. Plats 4 and 5 produced the best results, Plat 2 came next and plats 1 and 3 last.

Spinach, sown May 1. Bloomingdale grew more rapidly than Long Standing. Plats 4 and 5 gave best results, Plat 2 next and plats 1 and 3 last.

Beets, Dewings and Egyptian, each one row, sown May 21. The young plants appeared above ground June 1; they were thinned out July 11 and harvested October 17, with the following results, Plat 4 leading:—

PLATS.						Dewings.	Egyptian.	Total.
						Pounds.	Pounds.	Pounds.
Plat 1,	.	.	.	.	.	225	140	365
Plat 2,	.	.	.	.	.	240	155	395
Plat 3,	.	.	.	.	.	240	180	420
Plat 4,	.	.	.	.	.	245	240	485
Plat 5,	.	.	.	.	.	220	190	410

Celery, White Plume, one row, set out June 1. The plants were banked August 20; they were taken out October 28. Plats 4 and 5 showed best and plats 2 and 3 worst.

Kohlrabi, two rows, planted with young plants from the hot-bed May 18; they were harvested July 16, with the following results: —

	Pounds.
Plat 1, . . . . .	105
Plat 2, . . . . .	120
Plat 3, . . . . .	115
Plat 4, . . . . .	145
Plat 5, . . . . .	152

Cabbage, Red Dutch in all plats, varieties of other kinds only here and there in different plats. Judging from the general appearance of the crop, it seemed that plats 1, 2 and 3 were leading. On the whole the yield was quite satisfactory. No weights were taken, on account of the different varieties in the plats.

Tomatoes, Boston Market, two rows, set out May 30. Plats 2 and 3 showed the poorest development of the plants; they had the first few ripened tomatoes August 5. The following weights of ripe and healthy tomatoes were collected from different plats during the season: —

DATE.	PLATS.				
	1	2	3	4	5
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
August 25, . .	67.0	44.0	92.5	124.0	118.0
August 31, . .	65.0	11.5	63.0	211.0	257.0
September 8, . .	67.0	30.5	95.0	211.0	168.0
September 17, . .	99.5	65.0	84.0	101.5	98.0
Total, . . .	298.5	150.0	334.5	647.5	641.0

Potatoes, Beauty of Hebron, five rows, were planted in each plat May 1. The rows were three feet three inches apart and the hills two feet apart in the row. The young plants appeared above ground quite uniformly May 21.

The vines in all plats looked healthy throughout the season; they began to turn yellow first on Plat 2. The potatoes on all plats were harvested August 11 and 12, when the leaves were dead but the stems still green. They were smooth and free from scab. The different plats yielded the following weights of large, marketable potatoes and of small potatoes:—

PLATS.	Large Potatoes.	Small Potatoes.	Total.
	Pounds.	Pounds.	Pounds.
Plat 1, . . . . .	540	130	670
Plat 2, . . . . .	550	110	660
Plat 3, . . . . .	660	90	750
Plat 4, . . . . .	670	110	780
Plat 5, . . . . .	620	115	735
	3,040	555	3,595

This experiment will be continued during the coming season with the same crops and with the same mixtures of fertilizing ingredients, making such alterations as the experience of the past season suggests. The results of the first year are above presented without any further comment.

A critical discussion of the results is deferred to a later period in our investigation, when the experience of several years will furnish a safer basis for deduction.

#### 4. EXPERIMENTS WITH STOWELL'S EVERGREEN SWEET CORN FOR ENSILAGE (1891).

##### *Field D.*

The area occupied by this field is 328 feet long and 70 feet wide (22,960 square feet, or .53 of an acre). It runs parallel with Field C from east to west, and is separated from the latter by an unmanured strip of grass land 20 feet wide. The land has served in previous years for various field and garden crops, and was manured annually for several years back with 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre. The soil consists of a light loam, is fairly uniform and several feet in depth. It was ploughed during the autumn of 1890 and reploughed April 17, 1891. The same amount of fine-ground bone and muriate of potash as in preceding years was applied broadcast April 24 (315 pounds of the former and 105 pounds of the latter).

The entire field was planted May 2 with Stowell's Evergreen sweet corn; the seed did not come up very satisfactorily.

New seed corn was planted May 25 with good success; yet the crop remained late throughout the season. The crop with ears well developed, kernels in the milk, was cut for ensilage September 10. The total yield amounted to 17,800 pounds, or 16.9 tons per acre.

The whole plant was cut into pieces of from one to two inches in length, and without delay carefully packed into a silo in a way similar to that described in previous reports. The ensilage is designed to serve during the present winter season in feeding experiments, to compare its merits with ensilage prepared from a dent corn variety, Pride of the North, raised under similar conditions and of a corresponding state of maturity.

*Field E.*

This field was divided during the past year into two parts. The larger part was manured and planted in the same manner as Field D, with Stowell's Evergreen. The remainder was sown with several species of medicinal plants sent on for trial by the United States Department of Agriculture. The corn proved a success, and after being fully matured was cut. The ripe air-dry ears were subsequently collected; they weighed 729 pounds. The air-dry stover (2,520 pounds) served for a comparative feeding experiment with milch cows.

The majority of the seeds of the medicinal plants proved a failure. Opium poppy (*P. somnifera*), Russian rhubarb (*Rheum officinale*) and castor bean (*Ricinus communis*) did well.

*Fodder Corn (Stowell's Evergreen), Station, Field D.*  
(Cut Sept. 10, 1891.)

	Per Cent.
Moisture at 100° C., . . . . .	83.91
Dry matter, . . . . .	16.09
	<hr/> 100.00

*Analysis of Dry Matter.*

Crude ash, . . . . .	6.73
“ cellulose, . . . . .	26.03
“ fat, . . . . .	3.26
“ protein (nitrogenous matter), . . . . .	8.09
Non-nitrogenous extract matter, . . . . .	55.89
	<hr/> 100.00

5. EXPERIMENTS TO STUDY THE ECONOMY OF USING DIFFERENT COMMERCIAL SOURCES OF PHOSPHORIC ACID FOR MANURIAL PURPOSES IN FARM PRACTICE.

*Field F.*

The field selected for this purpose is 300 feet long and 137 feet wide, running on a level from east to west. Previous to 1887 it was used as a meadow, which was well worn out at that time, yielding but a scanty crop of English hay. During the autumn of 1887 the sod was turned under, and left in that state over winter. It was decided to prepare the field for special experiments with phosphoric acid by a systematic exhaustion of its inherent resources of plant food. For this reason no manurial matter of any description was applied during the years 1887, 1888 and 1889.

The soil, a fair sandy loam, was carefully prepared every year by ploughing during the fall and in the spring, to improve its mechanical condition to the full extent of existing circumstances. During the same period a crop was raised every year. These crops were selected, as far as practicable, with a view to exhaust the supply of phosphoric acid in particular. Corn, Hungarian grass and leguminous crops (cow-pea, vetch and serradella), followed each other in the order stated.

1890. — The land had been ploughed during the preceding fall, and again April 19, 1890. The field was subdivided subsequently into five plats of definite size, each running from east to west. These plats were separated from each other by a space eight feet wide.

The plats and spaces between them were ploughed and harrowed alike. The plats were fertilized at stated times; the spaces which separated them received at no time any kind of manurial matter.

The manurial material applied to each of these five plats contained, in every instance, the same form and the same quantity of potassium and of nitrogen, while the phosphoric acid was furnished in each case in the form of a different commercial phosphoric-acid-containing article; namely, phosphatic slag, Mona guano, apatite, South Carolina phosphate

(floats), and dissolved bone-black. The market cost of each of these articles controlled the quantity applied, for each plat received the same money value, in its particular kind of phosphate.

	Cost per Ton.
Phosphatic slag, . . . . .	\$15 00
Mona guano (West Indies), . . . . .	15 00
Ground apatite (Canada), . . . . .	6 25
South Carolina phosphate (floats), . . . . .	15 00
Dissolved bone-black, . . . . .	25 00

*Analyses of Phosphates used.*

[I. Phosphatic slag; II. Mona guano; III. Apatite; IV. South Carolina phosphate (floats); V. Dissolved bone-black.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . . . . .	0.47	12.52	0.09	0.39	15.96
Ash, . . . . .	—	75.99	—	—	61.46
Calcium oxide, . . . . .	46.47	37.49	—	46.76	—
Magnesium oxide, . . . . .	5.05	—	—	—	—
Ferric and aluminic oxides, . . . . .	14.35	—	—	5.78	—
Total phosphoric acid, . . . . .	19.04	21.88	36.08	27.57	15.82
Soluble phosphoric acid, . . . . .	—	0.00	—	0.00	12.65
Reverted phosphoric acid, . . . . .	—	7.55	—	4.27	2.52
Insoluble phosphoric acid, . . . . .	—	14.33	—	23.30	0.65
Insoluble matter, . . . . .	4.39	2.45	9.55	9.04	6.26

The following fertilizers were applied to the different plats April 17, 1890:—

Plat I. (south side), 6,494 square feet, . . . . .	{ 127 pounds of ground phosphatic slag. 43 pounds of nitrate of soda. 58 pounds of potash-magnesia sulphate.
Plat II., 6,565 square feet, . . . . .	{ 128 pounds of ground Mona guano. 43½ pounds of nitrate of soda. 59 pounds of potash-magnesia sulphate.



Plat III., 6,636 square feet, .	{	304 pounds of ground apatite.
		44 pounds of nitrate of soda.
		59 pounds of potash-magnesia sulphate.
Plat IV., 6,707 square feet, .	{	131 pounds of South Carolina phosphate.
		44½ pounds of nitrate of soda.
		60 pounds of potash-magnesia sulphate.
Plat V., 6,778 square feet, .	{	78 pounds of dissolved bone-black.
		45 pounds of nitrate of soda.
		61 pounds of potash-magnesia sulphate.

The phosphatic slag, Mona guano and South Carolina floats were applied at the rate of 850 pounds per acre, apatite at the rate of 2,000 pounds per acre; dissolved bone-black at the rate of 500 pounds per acre. These figures represent approximately the equal local cash values of the different sources of phosphoric acid applied. Nitrate of soda corresponds in all cases to an application of 290 pounds per acre, and the potash-magnesia sulphate to that of 390 pounds per acre.

The field was planted with potatoes, Beauty of Hebron; the large-sized ones were cut in halves, and the small ones left whole, when planted, May 1, 1890. The rows were three feet three inches apart, and the hills in the rows eighteen inches. Each plat had sixteen rows. The young plants came up quite uniformly; they were cultivated and hoed June 2. Several applications of Paris green with plaster were made during the season, to prevent damage by potato bugs. The crop looked well until the middle of July, when the effects of a serious drought showed itself to such an extent that the maturing seemed to be hastened on by it.

The potatoes were harvested from all the plats August 12 to 14. They were assorted in the field into marketable ones and small ones. The former were sold at sixty cents per bushel; the latter were used for chicken feed, at twenty cents per bushel, — our local market prices.

No. of Plat.	Total Yield of Potatoes (Pounds).	Marketable Potatoes (Pounds)	Small Potatoes (Pounds)
I. (south end), . . .	1,600	1,215	385
II., . . . . .	1,415	915	500
III., . . . . .	1,500	1,070	430
IV., . . . . .	1,830	1,380	450
V. (west end), . . .	2,120	1,590	530

*Yield per Acre.*

I. Phosphatic slag, . .	10,671	8,087	2,584
II. Mona guano, . . .	9,388	6,071	3,317
III. Ground apatite, . .	9,845	7,023	2,822
IV. South Carolina phosphate, . . . . .	11,886	8,963	2,923
V. Dissolved bone-black, . . . . .	13,626	10,218	3,408

*Statement of Percentages.*

Plats.	Marketable Potatoes (Per Cent).	Small Potatoes (Per Cent).
I., . . . . .	75.78	24.22
II., . . . . .	64.66	35.34
III., . . . . .	71.32	28.68
IV., . . . . .	75.40	24.60
V., . . . . .	74.91	25.09

*Money Value of Crop.*

[One bushel = 60 pounds.]

Plat.	Marketable Potatoes, at 60 Cents per Bushel.	Small Potatoes, at 20 Cents per Bushel.	Total Sum.
I., . .	134.6 bushels = \$80 76	43.0 bushels = \$8 60	\$89 36
II., . .	101.2 bushels = 60 72	55.3 bushels = 11 06	71 78
III., . .	117.1 bushels = 70 26	47.1 bushels = 9 42	79 68
IV., . .	149.3 bushels = 89 58	48.7 bushels = 9 74	99 32
V., . .	170.3 bushels = 102 18	56.8 bushels = 11 36	113 54

As a first year's results, the above statements were published without any further comment beyond the remark that the exceptional dryness of the season might have favored a superior action of the soluble phosphoric acid as compared with the insoluble one. Attention was also called to the important circumstance that an accumulation of phosphoric acid in the soil might eventually affect the results as time advances. The largest yield of potatoes had only removed 3.4 pounds of phosphoric acid from the soil.

Plat I. received 24.18 pounds of phosphoric acid.  
 Plat II. received 28.01 pounds of phosphoric acid.  
 Plat III. received 109.68 pounds of phosphoric acid.  
 Plat IV. received 36.12 pounds of phosphoric acid.  
 Plat V. received 12.34 pounds of phosphoric acid.

*Tabular Statement of the Approximate Amount of Nitrogen, Phosphoric Acid and Potash in the Crop raised.*

PLATS.	Pounds of Potatoes per Plat.	Pounds of Nitrogen in Tubers.	Pounds of Phosphoric Acid in Tubers.	Pounds of Potassium Oxide in Tubers.
I., . . . . .	1,600	5.440	2.560	9.280
II., . . . . .	1,415	4.811	2.364	8.207
III., . . . . .	1,500	5.100	2.400	8.700
IV., . . . . .	1,830	6.222	2.928	10.614
V., . . . . .	2,120	7.208	3.392	12.296

The calculation is based on E. Wolff's average analyses, 1,000 pounds of potatoes containing: nitrogen, 3.4 pounds; phosphoric acid, 1.6 pounds; and potassium oxide, 5.8 pounds.

1891. — The experiment was continued by selecting winter wheat as the next crop to be raised. For this purpose the soil was ploughed soon after the potatoes had been harvested, and subsequently manured and harrowed, as in case of the preceding crop. The change in the mode of manuring the different plats was confined to Plat III., which received no ground apatite, for the reason that none could be obtained

from the party that furnished our first supply of this article. No other form of phosphoric acid was substituted.

The following table shows the kind and amount of fertilizers applied to the plats:—

Plat I. (south side), 6,494 square feet,	$\left\{ \begin{array}{l} 127 \text{ pounds of ground phosphatic slag.} \\ 43 \text{ pounds of nitrate of soda} \\ 58 \text{ pounds of potash-magnesia sulphate.} \end{array} \right.$
Plat II, 6,565 square feet,	$\left\{ \begin{array}{l} 128 \text{ pounds of ground Mona guano.} \\ 43\frac{1}{2} \text{ pounds of nitrate of soda.} \\ 59 \text{ pounds of potash-magnesia sulphate.} \end{array} \right.$
Plat III., 6,636 square feet,	$\left\{ \begin{array}{l} 44 \text{ pounds of nitrate of soda.} \\ 59 \text{ pounds of potash-magnesia sulphate.} \end{array} \right.$
Plat IV., 6,707 square feet,	$\left\{ \begin{array}{l} 131 \text{ pounds of South Carolina phosphate.} \\ 44\frac{1}{2} \text{ pounds of nitrate of soda.} \\ 60 \text{ pounds of potash-magnesia sulphate.} \end{array} \right.$
Plat V., 6,778 square feet,	$\left\{ \begin{array}{l} 78 \text{ pounds of dissolved bone-black.} \\ 45 \text{ pounds of nitrate of soda.} \\ 61 \text{ pounds of potash-magnesia sulphate.} \end{array} \right.$

The wheat—two new French varieties of winter wheat, Hybrid Dattel and Hybrid Larned, sent on for trial by the United States Department of Agriculture—was sown Sept. 26, 1890. The young plants came up well, but were found winter-killed in the succeeding spring. The entire field was reploughed and seeded down with summer wheat in rows two feet apart May 11, 1891. The seed proved good and the crop did well during the entire season. A marked difference in the general character of the growth upon different plats could be noticed as the season advanced. Plats I. and V. were leading throughout the season, while Plat III. was least promising and matured last.

Following is a statement showing the height of the crop on the different plats at different periods of the season:—

PLATS.	June 16 (Inches).	June 28 (Inches).	June 30 (Inches).	July 7 (Inches).	July 14 (Inches).	July 21 (Inches).	Aug. 11 (Inches).
Plat I., . . .	12	20	29	31	46	48	48
Plat II., . . .	11	18	25	29	40	42	42
Plat III., . . .	7	11	17	22	28	34	34
Plat IV., . . .	12	18	25	29	41	45	45
Plat V., . . .	12	20	27	31	47	48	48

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The crop upon plats I., II., IV. and V. was cut August 14, and that on Plat III. August 18. The entire yield was moved into the barn August 20, where it remained stored until September 25, when the product of each plat was weighed and threshed, with the following results:—

PLATS.	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).	Percentage of Grain.	Percentage of Straw and Chaff.
Plat I, . . .	380	67	313	17.63	82.37
Plat II., . . .	340	73	267	21.47	78.53
Plat III., . . .	215	38	177	17.67	82.33
Plat IV., . . .	380	78	302	20.53	79.47
Plat V., . . .	405	59	346	14.57	85.43
	1,720	315	1,405		

An examination of the above tables shows that the total yield of wheat was highest upon Plat V., and lowest upon Plat III. The larger yield of Plat V. (dissolved bone-black) is in an exceptional degree due to the large production of straw and chaff, as compared with that of the grain. Plats II. (Mona guano) and IV. (South Carolina phosphate) yield the largest percentage of grain.

6. EXPERIMENTS WITH A WESTERN VARIETY OF DENT CORN, PRIDE OF THE NORTH, FOR ENSILAGE.

*Field G.*

This field is a part of a former meadow. Grass has been raised here for more than fifteen years in succession. A moderate top-dressing of barn-yard manure has kept the land in a fair condition for the production of hay. Eight years ago a row of drain pipes four inches in diameter was laid along its whole length. Branch drains pass into it in several places, to prevent the accumulation of water from surrounding localities. The land is nearly a level, and the soil a loam several feet in depth, here and there underlaid with a hardened clay. The area is 700 feet long and 75 feet wide, running from north to south to the east of Field A. During the fall of 1890 the sod was turned under and left over winter to disintegrate. During the late spring the soil was again ploughed and the remaining sod cut up with a wheel harrow. After subsequent harrowing it was planted May 13 with a dent corn variety, Pride of the North, in rows three feet three inches apart, the hills being two feet apart in the row. No manure was applied on that occasion, the object being to reduce the stored-up plant food, and thereby prepare the soil for future field experiments with special fertilizers.

The young plants came up well and made a handsome growth. At the time when the kernels began to glaze ten and two-thirds tons were cut to be converted into ensilage September 10. The remainder of the crop was cut September 16, to secure matured ears and corn stover. The air-dried stover thus obtained weighed, October 19, 4,185 pounds, and the ears 2,500 pounds.

The area used for ensilage corn, 25,650 square feet, yielded at the rate of eighteen tons and three hundred pounds per acre. The area turned to account for ears and stover, 26,850 square feet, produced at the rate of 4,056 pounds of ears and 6,782 pounds of stover per acre.

*Fodder Corn (Pride of the North), Station, Field G.  
(Cut Sept. 10, 1891.)*

	Per Cent.
Moisture at 100° C., . . . . .	71.86
Dry matter, . . . . .	28.14
	<hr/>
	100.00
<i>Analysis of Dry Matter.</i>	
Crude ash, . . . . .	8.78
“ cellulose, . . . . .	25.67
“ fat, . . . . .	2.24
“ protein (nitrogenous matter), . . . . .	7.62
Non-nitrogenous extract matter, . . . . .	60.69
	<hr/>
	100.00

### 7. EXPERIMENTS WITH GRASS LAND (MEADOWS).

The permanent grass lands are by their location arranged into two divisions, west and east of a public highway. They cover at present a space of sixteen to seventeen acres.

The *west side division* consists of old meadows, kept for over twenty years in grass. The area has for years been steadily reduced in size by turning, as circumstances advised, more or less at a time into plats for field experiments. In their present condition they surround our main field for experimental purposes. They are in part underdrained, and are kept, by a moderate annual top-dressing with barnyard manure, in a fair state of production, considering the condition of the sod. The area comprises to-day approximately not more than seven acres. Thirteen tons of hay, first cut, and two and three-quarters tons of rowen, hay of second cut, was the yield in 1891.

The *east side division* of meadows comprises an area of about 9.6 acres. The entire field to 1886 consisted of old, worn-out grass lands, overrun with a worthless growth on its more elevated portion, and covered with weeds and sedges in its lower section. The improvement of the land by underdraining and ploughing, and subsequently by the use of a system of drill culture, began in some parts (north end) in 1886, and in others (south end) in 1887. For the details of this work, as well as of the subsequent seeding down into permanent grass land, I have to refer to preceding annual reports.

It will suffice, for the appreciation of the present yield of these new meadows, to call attention once more to the following circumstances.

1886. — As soon as the drain tiles were covered and the ditches as far as practicable levelled, the entire area was ploughed, and the main depressions filled up with stones and earth, or earth, as circumstances advised, and left in that condition over winter.

1887. — The succeeding spring a wheel harrow was used to break up the rotten sod. The soil was subsequently



repeatedly ploughed and harrowed, until it showed the desirable mechanical condition required for a successful cultivation of summer grain crops.

Barley and oats were chosen as the first crops in case of the meadow north of the new roadway. Both were seeded in drills, with rows two feet apart, to permit a thorough destruction of an objectionable foul growth by a frequent use of the cultivator and hoe.

As soon as these crops were harvested, one ton of wood ashes per acre was ploughed in, to assist in the disintegration of the excess of organic peaty matter, and to serve as a general fertilizer. Ploughing once more and smoothing the surface by means of a brush harrow, the entire area was seeded down into grass to serve as meadow. The latter was subsequently cut into two, by a road built for communication to more remote fields. This arrangement caused a division into a northern and southern meadow.

1888. — In case of the land south of the roadway, leguminous plants, as soja bean, Southern cow-pea and serradella, served as first crop. The system of drainage and of seeding down remained the same as before. The meadow north of the road covers an area of somewhat more than six acres, and that south of the road is about three acres in size. The meadow north of the road was sown for the first time in the fall of 1887, with grass, and the one south of the roadway in the fall of 1888.

The more elevated portions of both were seeded down with the following mixture of grass seeds, at the rate of from two to two and one-half bushels per acre : —

Two bushels herds grass (*Phleum pratense*).

Two bushels red top (*Agrostis vulgaris*).

Two bushels Kentucky blue-grass (*Poa pratensis*).

Two bushels meadow fescue (*Festuca pratensis*).

Seven pounds sweet-scented vernal grass (*Anthoxanthum odoratum*).

Early in the succeeding spring a mixture of equal weights of medium red clover and alsike clover was added broadcast, at the rate of from five to six pounds per acre.

The lower and still more wet portion of the meadow was seeded down with the following mixture of grass seeds : —

Twenty pounds of soft brome grass (*Bromus mollis*).  
Twelve pounds herds grass (*Phleum pratense*).  
Nine pounds red fescue (*Festuca rubra*).  
Eight pounds fowl meadow grass (*Poa serotina*).  
Seven pounds Rhode Island bent (*Agrostis alba*).  
Six pounds orchard grass (*Dactylis glomerata*).  
Five pounds crested dog-tail (*Cynosurus cristatus*).  
Four pounds meadow soft grass (*Holcus lanatus*).  
Two pounds sweet-scented vernal grass (*Anthoxanthum odoratum*).

1889.—From four to five pounds of alsike clover per acre were added by broadcast seeding early in the succeeding spring (1889).

The seed came up well, and suffered but here and there in wet spots during the first winter. Barren spots were reseeded.

Both meadows were cut but once during the first summer season, somewhat later than usual; the majority of grasses did not, as might be expected, head out.

As soon as the first crop of hay was secured, a system of manuring was planned, which would illustrate the comparative manurial effect of top-dressing, as follows:—

By barn-yard manure.

By ground bones and muriate of potash.

By unleached wood ashes.

The northern meadow, consisting of six and one-half acres, was subdivided into three plats, I., II., III., running from east to west, leaving a space of twenty feet in width between them without any manurial matter.

The southern meadow was divided into two plats, IV., V. (south end). Plats I., II., III. were sown down in grass during September, 1887, and plats IV. and V. during September, 1888. The subsequent stated system of manuring began in the autumn of 1888, on all plats at the same time.

Plat I. (north end of the field) is equal to 1.92 acres. It was top-dressed during the fall and early spring with barn-yard manure, at the rate of eighteen tons per acre (1888–89).

Plat II. covers a similar area to Plat I. (83,640 square feet). It received at the same time a top-dressing of barn-yard manure, at the rate of eight tons per acre (1888).

The coarsest part of the barn-yard manure was subsequently removed from both plats before the growing grass interfered with its being raked off.

Plat III., about 2.41 acres, received, May 3, 1889, a top-dressing of six hundred pounds of fine-ground steamed bone and two hundred pounds of muriate of potash per acre.

Plat IV. (south of roadway), an area of 2.11 acres, received the same dressing, in the same proportion and at the same rate (six hundred pounds ground bone and two hundred pounds muriate of potash) per acre as Plat III. (1889).

Plat V., equal to .91 acres, received, as top-dressing, April 23, 1889, one ton of unleached Canada wood ashes, from our local market (1889).

*Yield of Hay in Case of Plats I., II. and III. (Second Year after Seeding), and of Plats IV. and V. (First Year after Seeding).*

PLAT I.	First Cut.	Second Cut.
1.92 acres, . . .	10,500 pounds, June 24.	4,370 pounds, August 26.

Total yield per acre, 7,745 pounds, or 3.87 tons.

PLAT II.	First Cut.	Second Cut.
1.92 acres, . . .	9,130 pounds, June 24.	4,650 pounds, August 26.

Total yield per acre, 7,177 pounds, or 3.59 tons.

PLAT III.	First Cut.	Second Cut.
2.41 acres, . . .	12,200 pounds, June 24.	4,950 pounds, August 26.

Total yield per acre, 7,116 pounds, or 3.56 tons.

Plat IV. (2.11 acres); Plat V. (.91 acres): The first year's hay consisted nearly entirely of herds grass, which was almost the only variety which had headed out in June. The yields of both plats were harvested together.

First Cut.	Second Cut.	Total Yield per Acre.
8,130 pounds, June 24.	3,105 pounds, August 31.	3,720 pounds, or 1.86 tons.

1890. — The different plats were prepared in a similar manner for the season of 1890 as they had been for the preceding season, 1889.

Plats I. and II. received a top-dressing of barn-yard manure during the months of October and November; the former at the rate of fourteen tons per acre, and the latter at the rate of eleven tons.

Plat III. was treated in April, 1890, as before, with a mixture of six hundred pounds of fine-ground bones and two hundred pounds of muriate of potash.

Plats IV. and V. were merged into one plat, and received a top-dressing of unleached wood ashes, at the rate of one ton per acre, April 19, 1890.

Barren spots in this plat, it being the second year after seeding down, were reseeded by the same seed mixture which had been used before.

The entire meadow received an addition of from two to three pounds of alsike clover seed, broadcast, per acre.

All plats were cut as far as practicable at the same time.

*Yield of Hay in 1890.*

PLAT I.	First Cut.	Second Cut.
1.92 acres, . . .	14,625 pounds, July 1.	3,790 pounds, Sept. 1.

Total yield of hay, 18,415 pounds.

Yield per acre, 9,591 pounds, or 4.80 tons.

*Yield of Hay in 1890 — Concluded.*

PLAT II.	First Cut.	Second Cut.
1.92 acres, . . .	12,480 pounds, July 1.	3,105 pounds, Sept 3.

Total yield of hay, 15,585 pounds.

Yield per acre, 8,117 pounds, or 4.06 tons.

PLAT III.	First Cut.	Second Cut.
2.41 acres, . . .	14,460 pounds, June 26.	3,535 pounds, September.

Total yield of hay, 17,995 pounds.

Yield per acre, 7,466 pounds, or 3.73 tons.

PLAT IV. (IV. and V., 1889.)	First Cut.	Second Cut.
3 acres, . . .	13,880 pounds, July 1.	4,080 pounds, Sept 3.

Total yield of hay, 17,460 pounds.

Yield per acre, 5,820 pounds, or 2.91 tons.

The total yield of hay on plats I., II. and III. averages 4.19 tons per acre. The total yield on Plat IV. averages 2.91 tons per acre.

The weight of the second cut of hay (rowen) averages about one-fourth of that of the first cut. The dryness of the season during the latter part of July affected seriously the yield of the second cut. The wet season of 1889, as compared with the dry season of 1890, as well as the difference in the age of the two meadows, renders further comparison not advisable at this early stage of our investigation.

1891. — The same system of manuring the different plats was adopted as in the preceding years; some reduction,

however, was made, with reference to the quantity of barn-yard manure applied per acre to plats I. and II., to ascertain the limit of its usefulness. Plat I. was top-dressed with barn-yard manure at the rate of 8 tons and Plat II. at the rate of 6 tons per acre. Plat III. received, as in previous years, as top-dressing 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre. The barn-yard manure was applied during the autumn and winter; the bone and potash early in the spring. Plat IV. received, as before, a top-dressing of wood ashes at the rate of 1 ton per acre early during the spring.

All plats were cut as far as practicable at the same time, with the following results:—

*Yield of Hay for the Year 1891.*

PLATS.	First Cut.	Second Cut.
	Pounds.	Pounds.
Plat I, per acre, . . . . .	6,528	1,446
Plat II, per acre, . . . . .	5,988	1,440
Plat III, per acre, . . . . .	4,641	1,015
Plat IV., per acre, . . . . .	3,750	1,610

The dry season has evidently seriously reduced the yield, as compared with the preceding year.

### 8. REPORT ON GENERAL FARM WORK (1891).

Aside from the farm work connected with the different field experiments previously described, much has been accomplished in other directions.

Considerable progress has been made in perfecting the arrangement for a system of co-operative work in the vegetation house and upon the experimental plats in the field.

The new orchard for testing the influence of different systems of fertilization on the health and general condition of fruit trees has received the needed attention. More young trees have been planted, and suitable crops have been raised over the entire area to economize the ground while the trees are still small.

Some reputed fodder crops comparatively new to our locality have been raised on a sufficiently large scale to serve for feeding experiments. Most prominent among them are a mixed crop of spring vetch and oats, and soja bean, both for green fodder.

Several acres have been planted with oats, barley and Indian corn, besides some varieties of roots and potatoes to furnish fodder for our farm live-stock.

Two silos are filled, one with Stowell's Evergreen sweet corn and the other with a dent corn, Pride of the North, to compare their feeding value as well as their general economical merits under fairly corresponding conditions.

A new barn has been built, to allow a proper separation of the crops obtained in connection with different field experiments.

A liberal production of fodder crops for the support of the farm live-stock has been for economical reasons a leading object in the management of the farm.

The improvement of the general condition of the various parts of the farm, wherever circumstances admitted a free choice of means, has received at all times deserved attention.

The following statement is an enumeration of the principal crops raised on different parts of the farm, on lands either

permanently assigned for the production of fodder for the live stock of the station or undergoing a course of preparation for future experiments.

	Tons.
Hay (first cut), . . . . .	38½
Rowen (second cut), . . . . .	10½
Fodder corn (green), . . . . .	22
Corn stover (dry), . . . . .	4
Roots (sugar beets, 2½; carrots, 1½; mangolds, 3 tons), . . . . .	7
Rye (1,303 pounds grain, 3,572 pounds straw), . . . . .	2½
Barley (1,838 pounds grain, 3,647 pounds straw), . . . . .	2½
Oats (2,194 pounds grain, 5,532 pounds straw), . . . . .	3½
Wheat (315 pounds grain, 1,405 pounds straw), . . . . .	½
Potatoes, . . . . .	1½
Vetch and oats (green), . . . . .	5½
Soja bean (green), . . . . .	4½
Miscellaneous crops, . . . . .	2



## 9. DEPARTMENT OF VEGETABLE PHYSIOLOGY.

REPORT BY PROF. JAS. ELLIS HUMPHREY.

During the past year the work of this department has gone on steadily, and with some interesting results. According to the plan indicated in our last report, the chief subjects of investigation during the winter and spring have been certain diseases of winter crops under glass. It is proposed to continue this line of work in the study of other such diseases, both because the equipment of the station affords facilities for such work, and because the extent of the green-house interest in Massachusetts renders such investigations appropriate and desirable. The writer will be glad to communicate with any person who suffers from any disease of plants grown under glass, and to receive diseased plants for study, as well as to render any service in his power to losers by open-air diseases in summer.

A very decided gain has been observable during the year in the importance and amount of the correspondence of the department and in the promptness and fulness with which inquiries addressed to persons who could furnish practical information to the department have been answered. This is gratifying, because it indicates that the efforts of the station to advance knowledge and disseminate information in the field of vegetable pathology, as well as in other lines in which its work has been longer established, are coming to be appreciated. As in the past, all correspondence will receive prompt attention.

The details of the year's work here reported are grouped under the following heads: —

1. The Rotting of Lettuce.
2. The Powdery Mildew of the Cucumber.
3. Various Diseases.
4. Preventive Treatment.
  - a. In Genearl.
  - b. For Smuts.

As heretofore, reference to the "General Account of the Fungi," in the seventh report of this station, will be found helpful to an understanding of these discussions.

THE ROTTING OF LETTUCE. — *Botrytis vulgaris* Fr.\*

Gardeners who cultivate lettuce as a winter crop usually suffer somewhat and often lose extensively by the rotting of the plant while still only partially grown. The trouble ordinarily appears first upon the stem of the plant, about at the surface of the soil. Here may be seen at first a soft, dark, decayed spot, which rapidly spreads, penetrating the stem and involving next the bases of the lower leaves. The latter, being thus cut off from the plant by the decay of their bases, usually dry up. With the further progress of the decay, the centre of the head, with the tender inner leaves, becomes attacked, and soon collapses into a fetid, slimy mass. In the decaying tissues one can often recognize fungus threads; and, if they are left undisturbed, there appear on the decayed remains the fruiting threads and spores of a fungus, always the same. When portions of the attacked tissues are removed and placed in a moist chamber after being thoroughly washed, I have found that the same fungus develops promptly and abundantly, and is never accompanied by any other. The study of specimens from various sources has led always to the same result.

Infection experiments with the fungus on healthy plants have been attended with little success; but the most that can be said is that their results indicate that the fungus requires for its attack conditions not yet determined. They do not negative the very strong evidence furnished by the constant association of the fungus with the decay. These experiments have not been carried so far as is desirable, on account of a lack of sufficient suitable material, and further cultures which I hope to make this winter may show that we have here a case similar to that described by DeBary,† in which the fungus threads require to be nourished saprophytically for a time before they can gain sufficient vigor to enable them to attack and live parasitically upon their host.

The fungus in question is one of the imperfect forms known as *Botrytis* or *Polyactis*, and agrees in many respects

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\* Two plates which had been prepared to illustrate the first two articles of this report, and delivered to the lithographer, were unaccountably lost in the mail before their engraving had been completed. It was impossible to duplicate the drawings in season for this report, but they will be prepared and published as soon as practicable.

† Botan Zeitung, 1886, Nos. 22-27.

with that described by Marshall Ward\* as causing a disease of garden lilies. It appears to be able to live saprophytically upon decaying vegetable substances, and is often found upon them; but I have never been able to detect any traces of decay in lettuce in a house where the fungus was not abundantly to be found. These facts point to the conclusion that this *Botrytis* is the cause of the rotting, and not merely an accompaniment of decay due to some other cause. It seems doubtful, however, if the affection can be called a disease in the sense that the fungus is able to attack perfectly sound, healthy lettuce under ordinary conditions. I have never seen the decay begin elsewhere than at the lower part of the stem; and it is possible that some injury or imperfection at that place is necessary to furnish a point of attack.

The structure of the fungus is very simple. From the creeping vegetative threads arise the erect spore-bearing ones, which branch sparingly toward their tips. The ends of the branches become slightly swollen, and from each is developed a number of short, peg-like projections. Each of these now begins to swell at its tip into a globular body, which increases in size and finally becomes elliptical in form. This is the spore, which, when ripe, falls from its attachment. The spores germinate promptly in water or a nutrient solution, by pushing out one or more threads each. These threads, when supplied with nourishment, grow rapidly into a much-branched mycelium. In a few days the erect spore-bearing threads begin again to be formed, as above described. Well-nourished specimens growing in a moist atmosphere may, after the first spore cluster has been formed, put out a new branch from the fertile thread, just below the cluster of spores. This thread then grows to a considerable length and then develops at its tip a new spore cluster; and this process may be several times repeated. The result of such a course of development is to produce what appear to be very long, fertile threads, with spore clusters scattered at intervals along them.

Instead of a spore cluster, a thread may produce, apparently only when it comes in contact with some solid substance, a compact cellular mass, which clings closely to the

surface with which it is in contact. These "organs of attachment" have been observed by several students of these fungi, but their real significance is not yet understood. The compact mass is formed by the interweaving and growing together of numerous short branches of the filament on which they are formed. I have noticed, also, that an abundant development of these organs is usually associated with the formation of few conidia, and *vice versa*. But the conditions which determine the preponderance of one or the other are very uncertain; for, in case of two parallel cultures prepared in the same way and carried on under apparently identical conditions, one produced abundant conidia and few attachment organs, while in the other the former were few and the latter were very numerous.

The history and structure of this fungus, as above described, would lead to the expectation that there will be found among the remains of the decayed plants the small, black masses of compacted threads known as *sclerotia*, which constitute the resting states of related fungi, and from which, finally, the perfect fructification is developed under favoring conditions. Careful examination of a quantity of material has failed to show any of these bodies; but it is by no means certain that they may not be formed, at least in some cases.

In its development, so far as observed, and in the details of its structure, this fungus appears to agree with the form known as *Botrytis (Polyactis) vulgaris* Fr., and is with little doubt the conidial stage of some sclerotium-producing *Peziza (Sclerotinia)*.

From what has been said, it is evident that the thorough and careful culture and vigilant supervision of the plants are essential to the control of the disease in question. The nature of the crop forbids the trial of fungicides, and chief attention must be devoted to the healthy growth of the plants. The soil should be rich and mellow enough to insure a rapid and vigorous growth. The temperature of the houses should not be allowed to rise above the rather low point which is most favorable to the growth of lettuce, since a higher temperature diminishes the vigor of the plant and at the same time favors the development of the fungus. Too

high a night temperature is probably a common cause of the rapid progress of the disease. All diseased plants and all refuse on which the fungus can live and increase should be removed at once from the greenhouse and burned. For this purpose the boiler furnace is conveniently at hand. Every bit of vegetable remains should be often and scrupulously cleaned up and destroyed. A house which has been badly infested by the disease should be thoroughly cleaned, fumigated with burning sulphur and supplied with fresh soil, before a new season's crop is started. A coat of paint or whitewash over the whole interior may also be a useful precaution. With a house thus disinfected and a crop well nourished and well cared for, one may legitimately expect practical freedom from loss by rotting.

THE POWDERY MILDEW OF THE CUCUMBER. — *Erysiphe cichoracearum* DC.\*

So far as I know, the first announcement of a powdery mildew on cucumbers, in America, was made in Bulletin No. 40 of this station in August last. It has long been known in Europe and has been observed in Australia. It is not known to me to attack cucumbers cultivated in the open air, but is probably not uncommon on plants forced in the greenhouse for a winter crop. It has been sent to this department by Dr. Jabez Fisher of Fitchburg and by Prof. L. H. Bailey of Cornell University, Ithaca, N. Y.

The disease ordinarily first appears on the upper surfaces of the leaves, and sometimes on the stems, of the host-plants, in the form of small, roundish, white spots, which have the peculiarly powdery appearance which has given to this group of fungi their name. These young spots suggest the effect of scattered splashes of flour upon the plant. Microscopic study shows that the white substance consists of the threads and spores of the parasite. The surface of the host-plant is covered by a close layer of flattened cells, the epidermis, and the vegetative threads of the parasite develop close to this outer surface. They are thus truly external, instead of ramifying among the internal cells of the host, as is the case with the cucumber mildew described in the last report

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\* See note, p. 219.

of this station (p. 210), and with most parasitic fungi. The only penetration of the host by this fungus occurs where its creeping vegetative threads send out, from slight lateral projections, short branches which grow downward, piercing the outer walls of the epidermal cells and swelling into club-shaped bodies within the cavities of these cells. By means of these club-shaped organs, the *haustoria*, the parasite obtains its nourishment by the absorption of the contents of the invaded cells.

The superficial threads grow and branch freely, and soon begin to send up erect, vertical threads, from which, after they have reached a certain length, spores are formed by the cutting off of the tip and of successively lower portions by consecutively formed cell-walls. Each oblong segment becomes, in its turn, rounded off at the angles and somewhat enlarged at the middle, and then falls from its support, ready for germination. On a well-developed thread one may thus see a chain of spores in all stages of development. These spores may vary considerably in size in specimens from the same source; but they do not usually, if ever, differ so widely as do those from Dr. Fisher's and Professor Bailey's specimens. Between the two there is a considerable difference in form as well as in size, which may point to a specific difference in the parasites from the two sources. The remarks concerning treatment of the disease of cucumbers will apply equally to both forms, whether they represent variations of the same species or not. These spores, when fully ripe, germinate readily in water, but do not develop far. Each gives rise to a germ-tube, usually near one of the original corners of the spore; but this tube rarely reaches a length greater than twice the short diameter of the spore. On nutrient gelatine, prepared with an infusion either of prunes or of cucumber leaves, the spores will develop no farther than in water; but in a drop of water on the surface of a living cucumber leaf they send a branch of the germ-tube downward, as a haustorium, into the underlying epidermal cell, and then grow and branch freely, until a considerable mycelium, forming a spot upon the leaf, is developed. From the readiness with which the leaf and stem and all succulent parts of the plant are attacked in this

way, the disease spreads rapidly, or may be artificially communicated to healthy plants.

Under favoring conditions of heat and moisture the spots increase very rapidly in size and in numbers. Those upon a leaf may become confluent and involve the whole leaf. The attacked tissues soon become yellow and then brown and dry, and the plants are rendered worthless, if not utterly killed. The parasite is not limited in its attacks to weak or poorly nourished plants; but on strong and vigorous ones it often progresses more slowly, and less completely overcomes its host than when the latter is enfeebled from some other cause. This can readily be seen in plants grown respectively on poor and rich soils, but otherwise under similar conditions.

The structure of the summer-spore stage described shows plainly that this parasite is one of the *Powdery Mildews*, and heretofore its perfect or winter form has been unknown. It has therefore been impossible to say to what particular species of the group it should be referred. It has been known as the variety *Cucurbitarum* of *Oidium erysipoides* Fries, which embraces various undetermined summer-spore stages of this group. But during last December, on several of the leaves of cucumber plants on which the disease had been allowed for six weeks to run its course, and which were covered by the summer spores of the fungus, there appeared smoky spots perhaps half an inch in diameter. On these spots were seen the young yellow and brown spore-fruits or *perithecia* of the winter stage. These soon reached maturity, and furnished the means for specific identification of the parasite. The dark-brown ripe *perithecia* are provided with irregular brownish appendages around their bases, and contain several spore-sacs each. Each spore-sac contains typically and most commonly two spores; but this number is often reduced to one, and less often rises to three or even four. A careful comparison of this fungus with the described species of the genus *Erysiphe*, to which it plainly belongs, shows it to agree in all essential details of structure, *perithecia*, haustoria, etc., with *E. cichoracearum* DC. The appendages of the *perithecia* are distinctly brown in mature specimens, but less deeply colored than is usually the case

with those of this species developed in the open air. This difference may, however, well be due to the different conditions under which they have developed.

It is interesting to find that this parasite, so destructive under the given conditions, is the same with one of our commonest out-of-door species in summer and fall on various *Compositæ*, asters, golden-rods and sunflowers, on *Verbenas*, on *Phlox*, and on various other host-plants, to which it does comparatively little harm.

Professor Bailey and Dr. Fisher, as well as the writer, have found that this disease may be kept in check in the greenhouse by spraying the plants as often as is necessary with a solution of sulphide of potassium (liver of sulphur) in water, an ounce of the sulphide to four gallons of water. A stronger solution injures the plants and fruits. Spraying with the ammoniacal carbonate of copper has been found even more effective. But Professor Bailey finds more effective than either exposure to sulphur vapor. This is accomplished by closing the house as tightly as possible for half an hour or an hour at a time, while it is filled by the vapor arising from a vessel of sulphur kept a little above the melting point on a small oil stove. The vessel should be porcelain lined, to protect the iron from the action of the sulphur. This vapor appears to be harmless to the host-plants while fatal to surface parasites like the powdery mildews. Great care must be taken to avoid the ignition of the sulphur, since a few minutes' exposure to the fumes of burning sulphur would be fatal to a house full of plants; but, with reasonable care in protecting the sulphur from contact with the flame and in preventing the temperature from rising too high, there should be no danger of such a catastrophe.

A house in which this disease has been troublesome should be thoroughly disinfected by burning sulphur before a similar crop is again started. The soil should be entirely removed and replaced by fresh. But that removal of the earth is not alone sufficient has been clearly shown during the past season. The house in which the study of this disease was carried on during the winter and spring of 1891 remained dry and unused during August, and early in September the soil was wholly removed. New bottoms were



put in the benches, which were then filled with fresh soil. A lot of new cucumber plants were started, and in October were abundantly and spontaneously attacked by the fungus in question. There is little doubt, however, that thorough fumigation will render a house clean, so far as fungi are concerned.

#### VARIOUS DISEASES.

*A New Potato Disease.* — Late in July last, Mr. G. D. Howe of North Hadley brought to the station some specimens of potato plants whose leaves bore spots in many respects strongly resembling those produced by the rot-fungus in the early stages of that disease. He reported that the disease was spreading over an extensive field and killing the plants. A visit to the field confirmed these statements, and showed that those plants which suffered most were those which were nearest maturity, although the foliage had not yet turned yellow from natural causes. Some rows of late potatoes, which were still vigorously growing and very green, although between infected rows, were almost free from the disease. The field had been lately sprayed as a protection against rot; and another spraying of certain rows was recommended, to test the possibility of checking the spread of the disease by this means. But its spread was so rapid that the plants were killed before time could be found to make the application. The tubers were not affected in any case beyond a probable slight loss of growth, and remained perfectly marketable. A pretty thorough and careful examination of the diseased leaves showed the constant presence in the spots of mycelium, from which were developed, on the lower surface of the leaves, spore threads and spores of the form-genus *Macrosporium*. This was clearly not simply a saprophytic form following the attack of some parasite, but occurred on the very young spots with a truly internal mycelium, and had all the appearance of a true parasite.

Circumstances made it impossible to study the disease further at the time; but it seems probable that we have here a new disease of potatoes which may prove of considerable importance. Mr. Howe is confident that the same disease

attacked some of his potatoes in 1890, though in a less serious form. It attacked, during August, as Mr. Howe informs me, many other fields in Hadley, where it appears to have been quite general. The report from various parts of the State of the appearance of potato "blight" without the "rot" leads one to ask if this disease may not have been much more widely spread than is known; and the especial object of this note is to call the attention of others to it, and to ask readers of this report to forward at once to the station specimens of any potato plants which are observed to be attacked in this way. A careful watch will be kept in Hadley for the disease, and arrangements will be made to give it the attention it deserves should it reappear.

*Another Disease of Cucumbers.* — In connection with the study of the powdery mildew of the cucumber, above described, there were received from Dr. Jabez Fisher of Fitchburg specimens of cucumber plants which were attacked by a still more serious disease than the mildew, and one apparently much more difficult to control.

This disease is characterized by a dwarfed and stunted appearance of the shoots attacked. The young fruits become deformed and distorted, and some of the leaves which reach a considerable size, perhaps because they are attacked late, turn yellow and die. Sometimes a plant will push out a new and vigorous shoot which may grow for a time, but sooner or later is pretty sure to succumb. Over the lower surface of these yellow leaves may be seen, on close examination, a delicate, white, glairy film, which recalls by its appearance a very thin dried streak of some albuminous substance. Microscopic study of this film shows it to be a web of very fine interlacing fungus threads, closely adherent to the surface of the leaf. No spore formation was ever observed on the leaves as they come from the forcing-house; but when a fresh leaf, covered with a well-developed film, was placed in a moist chamber, the threads gave rise in two or three days to numerous short, erect stalks, irregularly scattered along their sides. These stalks taper somewhat toward their tips, which are rounded or slightly knobbed, and bear the elliptical or rather kidney-shaped spores of the fungus. These spores, when placed in water, swell up by

absorption of water until they become nearly or quite spherical in form, and then germinate by extending a germ-tube nearly as large as the average of the vegetative filaments of the fungus. Lack of suitable material has prevented the culture of this fungus on nutrient media or attempts to inoculate cucumber plants with the fungus, but everything points to this fungus as the cause of the trouble.

From the description given it is evident that it is one of the numerous uncertain and little-known fungus forms; and, according to our present system of classification, it must be placed in or very near the form-genus *Acremonium*. Should the disease reappear the coming winter, special attention will be given to it and especially to the determination of its etiological relation to the disease in question.

The present incomplete note is here inserted as a preliminary record of a new disease of cucumbers and of what has been observed in connection with it, with the primary object of calling the attention of other pathologists and of growers of cucumbers under glass to it. It is especially requested that any person who observes this or any similar disease will promptly notify the writer of its presence, and send specimens and all possible details concerning its appearance and spread. Dr. Fisher states that this disease reduces the yield of badly attacked plants to ten per cent. of the normal. It seems difficult to combat, as it steadily increased in his houses in spite of applications of all the most efficient fungicides.

*Rye Fungi.*—The winter rye on the station plots was attacked severely by three fungi. In June many of the leaves showed the swelling and distorting effect of the leaf smut (*Urocystis occulta* Wallr.), further details concerning which will be found in another part of this report. It has not as bad a reputation and is not as well known as the grain smuts, but it undoubtedly does much harm in weakening the plant and so in reducing the production of both grain and straw.

At the same time with the smut there appeared in extensive orange patches on the leaves the summer spores of one of the grain rusts (*Puccinia rubigo-vera* (DC.) Wint.), so abundantly that they arose in clouds when the plants were

shaken. Later the leaves of summer wheat on adjoining plots were very badly affected. In July this stage of the fungus had largely disappeared, and the leaves of the rye were blackened by the winter-spore pustules of the same fungus.

The life-histories of this and the related species of rusts are not yet fully understood, and our only protection at present is in destroying as completely as possible the stubble and all refuse which can harbor their spores in the field. Observations by the writer, made as his share in certain co-operative studies of the grain rusts, seem to indicate that this rust does not survive the winter in its host-plant, but depends upon fresh infection in the spring. On our plots the summer-spore pustules on rye seedlings survived the early frosts, and seemed vigorous until the heavy frosts and first snowfalls. The plots were then covered continuously by snow until spring. When they were again exposed, the discolored spots where the spore-pustules had been could be readily observed, and examination showed a mycelium to be present in the spot. But it was apparently dead, for repeated examination of the plots failed to detect new spores breaking out from any of these old spots. The fungus was not observed after growth was resumed until early in June, when a few warm and moist days increased the amount present from a few scattered spots to a general epidemic.

The virulence of this attack of rust caused a marked weakening of the plants, as was shown by the yellow color of their leaves and by the abundant presence upon the leaves—most abundant on the weakest ones—of the saprophytic fungus form known as *Cladosporium herbarum* (Pers.) Lk. The sooty patches of this with the orange masses of the rust pretty completely covered the leaves and left little or no normal tissue.

It is noteworthy, as illustrating the general principle repeatedly laid down in these reports, that on those plots which had been supplied with abundant and readily available nitrogen the effects of the fungi were much less serious than where the supply of nitrogen was deficient in quantity or in availability. The difference was especially striking in respect to the discoloration of the leaves, which was less in

proportion to the amount of rust present on the well-fed plants.

*The Club Root of Cabbages* (*Plasmodiophora Brassicae* Wor.) appeared for the first time on a part of the station grounds during the past season. The first specimens were obtained when the largest leaves were about six inches long. At this time, in the worst specimens the main root and its lateral branches were attacked and swollen into a nearly solid mass of the size of a hen's egg. The parts of the affected plants above ground did not at this time differ essentially in appearance from their neighbors, and were recognizable chiefly by the fact that in warm, sunny weather the foliage became wilted from the lack of sufficient root hairs on their swollen roots to absorb the necessary water to supply the demands of active transpiration. These plants failed entirely to form "heads," and were therefore rendered worthless by the disease. Microscopic examination of the diseased roots at different times showed the various stages in the development of the parasite as they have been described and figured by Woronin.

Early in the season, just after the spring ploughing, soil was taken from a field which had been planted to cabbages the previous season and had produced a considerable number of "stump-footed" ones. This soil was placed in a flower-pot in the greenhouse and sown with cabbage seed. In due time some of the seedlings were attacked by the club root fungus in characteristic fashion, this showing the survival in the soil and their probable pretty general distribution through it, after ploughing, since a single flower-pot full taken at random contained at least several of them.

It is a matter of general observation among market gardeners and others that on some soils, especially heavy and moist ones, it is not profitable to plant cabbages two years in succession, on account of the prevalence of club root the second year. But it has also been remarked that two crops equally free from disease may be raised in one season. This fact is interesting as a practical demonstration of the fact that the spores of the club-root fungus are *resting spores*, and require a season of quiescence before they are able to germinate and reproduce the disease.

After a year or two of other than cruciferous crops (cabbages, turnips, radishes, etc.), the danger from the disease is past, and the latter may again be planted for a year.

*The Blight of Celery*, which forms spots on the leaves, is due to a parasitic fungus form which bears summer spores, known as *Cercospora Apii* Fres. That this represents merely an imperfect form of some fungus whose perfect form probably lives saprophytically, cannot be doubted; but no other form has thus far been connected with it. I have observed on celery, from the farms of Messrs. W. D. Philbrick of Newton Centre and A. H. Smith of West Springfield, that, after the brown blight spots have spread over the leaves and they have collapsed upon the ground, there appear upon them the tiny black pustules of one of the pycnidial forms known as *Septoria*. From the analogy of other cases and from the evidence of a series of specimens in different stages of the disease kindly sent by Mr. Smith, it is easy to believe that the *Septoria* form represents another stage in the history of the same fungus to which the *Cercospora* form belongs, although I have not been able to make cultures. One would, however, expect little additional evidence except from cultures of the perfect spore-form, which we do not yet know.

Since there have already been described several so-called species of *Septoria* on various umbelliferous plants which differ in no essential particulars from this form and from each other, it would be worse than superfluous to add here another to the already large list of names which have been given to what must eventually be shown to be a single form. And especially so since this form is undoubtedly merely an imperfect stage in the life cycle of some fungus for which, when its whole course of development is known, only a single name can stand; while the host of names inconsiderately given to its various imperfect forms will constitute only a cumbrous and useless synonymy. So far as it has been possible to examine material and descriptions, it appears that this form on celery is separated by no distinct features from the following previously described ones on *Umbelliferae*: *S. Sii* Rob. & Desm., *S. Cryptotaeniae* E. & Rau, *S. Saniculae* E. & E., *S. Dearnessii* E. & E. and *S. Petroselini* Desm.

Our form may be described as follows : Pycnidia appearing on the brown leaves after the coalescence of *Cercospora* spots, amphigenous, black, scattered, 100 to 160 mmm. in diameter ; flattened when of the larger, globular when of the smaller, diameter ; pycnosporos somewhat curved, slightly tapering to both ends, usually 3-septate, rarely 2- or 4-septate, 24.-34. x 1.7-2. mmm.

It remains much to be desired that the perfect form of this fungus should be discovered. It will probably be found eventually on blighted celery leaves which have lain on the ground through the winter, or on rubbish near by, in spring.

*Note.*—Since the above was written Mr. F. D. Chester, of the Delaware Experiment Station, has described \* what is doubtless this form as occurring on celery in that State, and thinks it may be that known in Europe as *Septoria Petroselinii* Desm., var. *Apii* Briosi.

*Clover Fungi.*—Two fungi annually cause much damage to the clover on the station meadows and elsewhere in Amherst and in other parts of the State. One of these is the rust fungus (*Uromyces Trifolii* (Hedw.) Lév.), which is most harmful in its summer and winter spore stages, which are developed almost simultaneously in June and July. They appear in the form of pustules of different shades of brown, which burst through either surface of the leaf, and consist of the closely packed spores of the fungus.

The other fungus is the black mould (*Polythrincium Trifolii* Kze.), which appears in thickly scattered black spots over the under surface of the leaves. This form is often followed by the development of black crusts on the affected leaves, which have been named *Phyllachora Trifolii* Pers., and are supposed to represent the perfect form of the fungus ; but the winter spores which should develop in them have never been described.

Both of these fungi reduce the fodder value of the clover to a minimum, and cause considerable reduction in the size of the leaves and in the general vigor of the plant, and are therefore real pests and sources of real loss.

*A Fish-hatchery Fungus.*—Early last spring I received from the Northampton fish-hatching establishment, through

Dr. J. B. Paige of the Agricultural College, specimens of trout eggs attacked by fungous filaments. These filaments were not in the fruiting stage; but when dead flies were thrown into the water containing the eggs, they were promptly attacked by similar filaments, which soon developed both non-sexual and sexual reproductive organs, from which the fungus was readily determined as *Achlya racemosa* Hild. I am informed by H. E. Maynard, Esq., of Northampton, that the eggs suffer most when first placed in the hatching trays. It is generally believed that only dead eggs are attacked; yet the fact, which is commonly observed, that, if the eggs are not removed from the trays as fast as they die, the fungus will extend to all the eggs, shows plainly that this cannot be the case. If it were able to attack only dead eggs, the fungus could not be a source of harm, and its presence in the trays could not endanger living eggs. It does not, as far as I can learn, attack the young fry after hatching.

The only effective means of preventing the spread of this affection lies in the frequent removal of all dead eggs from the hatching trays.

*Rust of Poplars.*—The European black poplar (*Populus nigra* L.) has been considerably planted on the grounds of the Agricultural College and elsewhere in Amherst.

The trees are attacked annually in September by the poplar rust (*Melampsora populina* (Jacq.) Lév.), and during the past two seasons the attacks have been very severe. The disease first shows itself in the yellowing of the lower leaves, due partly to the fading of their natural color in consequence of the presence of the parasite, and partly to the development on their lower sides of the abundant deep-yellow summer-spore masses of the rust. There now follows a definite upward progress of the disease, and when the middle part of the tree is reached, the lower leaves are falling in great numbers and the lower limbs soon become stripped of foliage. This results in two to three weeks after the first appearance of the disease. By the time they fall the leaves have become brown in color, from the further degeneration of their pigment and the replacement of the summer spores by the brown crusts of compacted winter



spores. The leaves then lie upon the ground until spring, when the winter spores germinate and infect the new season's foliage.

It is evident that much of the harm done by this rust in rendering the trees unsightly and in causing premature defoliation can be avoided by thoroughly cleaning up and burning all the fallen leaves before snow falls, while the winter spores are still incapable of germination.

*Anthracnose of Chestnut.* — Since the cultivation of the chestnut is beginning to receive attention in some quarters, and bids fair to be attended with considerable success, it may be worth while to mention a fungus which, from its prevalence on wild chestnuts about Amherst, seems likely to prove troublesome to the cultivated plant. This fungus, which must be known as *Marsonia ochroleuca* (B. & C.), causes an anthracnose of the leaves in the form of small, thin, bleached spots, on which the spore pustules are formed. These spots are sometimes so abundantly developed as to cause the leaves to shrivel and die; and the fungus may be expected to do much greater harm to trees growing under the artificial conditions of cultivation.

*The Black Knot of the Plum.* — The study of this disease has been continued during the past year, both theoretically and practically. Some trees in an advanced stage of the disease have been put in charge of this department for treatment, and progress has been made in both lines of study. But the results obtained have not been so complete as was hoped for, partly on account of the limited material at my disposal and partly because a large amount of time was required for other studies reported here. Therefore it seems best to reserve the results obtained until they can be combined with those hoped for during the coming year, in a more complete and hence more satisfactory account.

*Diseases of Tobacco.* — This department has communicated with some leading tobacco growers in the Connecticut valley during the past fall, with a view to the investigation of the various diseases or affections to which tobacco is subject in the curing shed. These are known chiefly under three names, white vein, pole sweat and pole rot. How far these names represent affections due to distinct causes it is

impossible to say, since they have apparently caused no loss in this State during the past season, and it has not been possible to obtain material for study. The purpose of the present note is to call the attention of tobacco growers to the fact that the department is desirous of studying the diseases named, and to ask them to notify the writer of the existence of any such in their barns next season. It seems very probable that much can be done towards a better understanding of the nature and means of prevention of these sources of loss. The writer desires here to thank those growers who have so promptly replied to his inquiries, and hopes to be as promptly informed of the existence of opportunities for the study of these diseases.

#### PREVENTIVE TREATMENT.

A somewhat extended account of the principles underlying the preventive treatment of fungous diseases of plants, with detailed directions for the preparation and application of the most efficient fungicides, was issued as Bulletin 39 of this station, in April last. That interest in this subject is being awakened was shown by the demand for the bulletin and for further information; but it is impossible to say to what extent its recommendations were acted upon, as very few persons have communicated to the department any report of such treatment or its results. The bulletin named can still be furnished, on request; but the more important points of the discussion are given below.

Since a plant which is once fairly attacked by a fungus is lost, treatment must be directed toward preventing the development of fungi upon the plants to be saved. Protective measures may be of two sorts; those which remove possible sources of infection from the plants, and those which fortify the plants against infection. The latter of these objects is accomplished by the use of *fungicides*; the former may be largely accomplished by *hygienic treatment*.

There are definite laws of health for plants as well as for animals, and in one case, as in the other, neglect of those laws invites disease. In the first place, plants which are expected to grow and thrive must be furnished with an abundance of the materials necessary to growth. Weak,

poorly nourished plants suffer the attacks of parasites of all sorts, and have no power to resist them. Secondly, where a crop has suffered from a fungous disease in one season and a good crop of the same kind is desired in the following season, every tangible trace of the disease must be removed. For example, if a vineyard has suffered from *mildew* or *black rot*, all diseased leaves and berries should be collected at the end of the season with scrupulous care and wholly burned; and the same advice applies to a large list of cases. Thus incalculable numbers of the spores of the fungi of the respective diseases will be prevented from infesting the next season's crop. In some cases where the spores remain in the soil, as in the *stump foot* of cabbages or the *smut* of onions, the attacks of the disease can only be avoided by rotation with crops upon which the fungus in question cannot live. Thirdly, wild plants, which, being nearly related to a given cultivated one, may be subject to the same disease, or which bear a complementary spore form of a pleomorphic fungus, should be carefully excluded from the neighborhood of cultivated ones. Thus, wild cherries or plums, which are equally subject to the *black knot*, should be kept away from plum orchards; and spinach fields should be kept free of pig-weed, since both plants are attacked by the same *mildew*; and again, since red cedars bear one spore-form of a fungus whose other form is the *rust* of apple leaves, it is plain that they should not be allowed to grow near an apple orchard.

The importance of these preventives is often underrated by persons who understand and use successfully other forms of treatment. It is evident, however, that, in removing as completely as is possible the conditions which favor the abundance and increase of a fungus in the vicinity of its host plant, half the battle is won. When this has been done, we may protect the plants by the external application of *fungicides*.

These preparations, when properly prepared and when applied at the right times and in the right way, have been abundantly proved to be of the greatest value, and often to determine the difference between a full crop from plants on which they are used and practically no crop where they are not applied.

But the fact cannot be too strongly emphasized that everything depends upon how they are prepared, and upon *how* and *when* they are applied. The following pages attempt to give somewhat full instruction *how* to prepare and apply the most valuable fungicides, and such general hints *when* to apply them, as will be of service. The proper times for their application vary so much with special conditions, however, that instructions on this point must form an important part of the special directions for any particular case.

*Preparation.*—The protective quality of most of the best fungicides lies in the fact that they contain a certain proportion of copper; and, of the four recommended as applicable to most cases of fungous diseases, three contain it as the essential constituent.

The Bordeaux Mixture requires six pounds sulphate of copper, four pounds quicklime (fresh) and twenty-two gallons water. The sulphate of copper, known to the trade also as blue vitriol or blue-stone, is dissolved in two gallons of water. The solution will be hastened if the water be heated and the sulphate pulverized. After the solution is complete, fourteen gallons of water are added to it. The quicklime is slaked in six gallons of water, and stirred thoroughly until it forms a smooth, even mixture. After standing for a short time it is again stirred and added gradually to the sulphate solution, which is thoroughly stirred meanwhile. The mixture is then ready for use, though some experimenters recommend further dilution to twenty-five or thirty gallons, for certain uses. It should not be prepared until needed, and should be used fresh, as it deteriorates with keeping. Since the lime remains merely in suspension and is not dissolved, the mixture should be strained through fine gauze before entering the tank of the spraying machine, so that all of the larger particles which might clog the sprayer may be removed.

Ammoniacal carbonate of copper, in its improved form, is prepared from three ounces carbonate of copper, one pound carbonate of ammonia and fifty gallons water. Mix the carbonate of copper with the carbonate of ammonia, pulverized, and dissolve the mixture in two quarts of hot

## 220 AGRICULTURAL EXPERIMENT STAT

Many cultivated plants suffer the attacks of  
insects, and have no power to resist them. If  
a plant has suffered from a fungous disease,  
and a crop of the same kind is desired  
season after season, trace of the disease  
is common. If a vineyard has suffered  
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	Cents per Pound.
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carbonate, . . . . .	15
onate, . . . . .	3
ionia (24°), . . . . .	10
n sulphide, . . . . .	25

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in the form of a very fine spray to the surface of the  
s until they are thoroughly wetted. This, drying,

water. When they are wholly dissolved, add the solution to enough water to make the whole quantity fifty gallons. This preparation has been found to be better and cheaper than that made according to the original formula, which is as follows: Dissolve three ounces carbonate of copper in one quart aqua ammonia (22° B.),\* and add the solution to twenty-five gallons of water.

Dr. Thaxter, formerly of the Connecticut Experiment Station, has suggested that a very large saving may be made by preparing the carbonate of copper by the following method, instead of buying it, as its market price is much greater than that of the materials necessary for its preparation: Take two pounds of sulphate of copper and dissolve it in a large quantity of hot water; in another barrel or tub dissolve two and one-half pounds of carbonate of soda (sal-soda) in hot water. When both are dissolved and cooled, pour the soda solution into the copper solution, stirring rapidly. There will result a blue-green precipitate of carbonate of copper, which must be allowed to settle to the bottom of the vessel. Now draw off the clear liquid above the sediment, fill the vessel with fresh water and stir up the contents thoroughly. After the copper carbonate has once more settled to the bottom, again draw off the clear fluid above. The carbonate may now be removed from the vessel and dried, when it is ready for use. From the amount of blue-stone and sal-soda given above will be produced one pound of copper carbonate, and the amount of each necessary to produce any given amount of copper carbonate is easily calculated.

Sulphate of copper is used in solutions of varying strength for certain special cases.

Sulphide of potassium, known also as sulphuret of potassium or liver of sulphur, has been found useful in the treatment of diseases caused by those fungi known as powdery mildews, especially on plants grown under glass. It is ordinarily used in the proportion of half an ounce of the sulphide to one gallon of water.

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\* Dealers usually handle ammonia water of a strength of 24° B. (= 22.5% ammonia) or of 26° B. (= 26.5% ammonia). To reduce these to the required strength, 22° B. (= 19% ammonia), add *four* parts of water to *ten* of aqua ammonia of 26°, or *two* parts of water to *ten* parts of 24° aqua ammonia.

*Materials.*—For the convenience of persons who may wish to purchase the necessary materials for the preparation of fungicides, the writer has communicated with several reliable houses in some of the larger cities of the State, and has received from those named below favorable replies as to their readiness to fill orders promptly, and as to prices. He can, therefore, recommend these firms to persons wishing fungicide supplies, without in any respect implying that there are not many others equally reliable:—

Weeks and Potter Company, 360 Washington Street, Boston.

Messrs. E. & F. King, Boston.

Talbot Dyewood and Chemical Company 24 and 26 Middle Street, Lowell.

Jerome Marble & Co., Worcester.

Messrs. H. & J. Brewer, 463 Main Street, Springfield.

Concerning the cost of the various materials named above no very exact figures can be given, since prices vary with the state of the market and according to the quantity ordered. Prices per pound are considerably higher for small quantities than for larger ones, and the substances cost *much* less in original packages than in smaller lots. A large saving can be effected if several persons will combine in ordering what they need, both in the cost per pound of the chemicals and in cost of transportation. The following quotations may be given as the approximate prices of the various substances in *small* lots, at retail, and discounts from these prices will increase with the amount of the order:—

	Cents per Pound.
Copper sulphate, . . . . .	8
Copper carbonate, . . . . .	60
Ammonium carbonate, . . . . .	15
Sodium carbonate, . . . . .	3
Aqua ammonia (24°), . . . . .	10
Potassium sulphide, . . . . .	25

*Application.*—In the case of diseases caused by fungi which spread from plant to plant during the growing season, the necessary protection is afforded by applying the fungicides in the form of a very fine spray to the surface of the plants until they are thoroughly wetted. This, drying,



leaves a thin film over the plants, which is fatal to fungus spores that may fall upon it. Suitable spraying apparatus is of the first importance to success in the use of fungicides, especially a nozzle which shall allow the escape of only the finest spray. The ordinary spraying nozzles used with hose or with small hand pumps are utterly unsuited to this purpose. The best form is, perhaps, that known as the Vermorel nozzle, which is furnished with many pieces of apparatus, or may be purchased separately. This nozzle gives a very fine and steady spray, which may be instantly cut off, and is the best suited for the Bordeaux mixture, since it has an attachment for promptly freeing it of clogging particles. Another excellent nozzle for the other fungicides described, which are clear solutions, is the Nixon nozzle.

For supplying the necessary pressure to drive the liquid through the nozzle in the form of spray, some form of force pump is necessary. The form chosen must depend on the amount of work to be done and the character of the plants to be treated. We may distinguish three general types. The *knapsack* type is suitable for almost any small job, the importance of which does not justify the purchase of a more expensive apparatus, and is especially adapted to use upon low-growing plants cultivated in hills or rows. These machines have a tank holding a few gallons with a pump worked by a lever with one hand, while the other hand directs the nozzle, the apparatus being strapped upon the back of the operator. The *hand-cart* type of pump consists of a large reservoir, representing the body of the cart, connected with a force pump, and the whole mounted on two or three wheels with a handle for pulling or pushing. The *horse-cart* type of machine includes a larger reservoir and more powerful pump, capable of throwing several streams, mounted on wheels, to be drawn through the field or orchard by horsepower.

For information concerning the details and prices of the numerous spraying machines on the market, the reader is referred to the catalogues, which will be sent on application, of the Nixon Nozzle and Machine Company, Dayton, O.; The Goulds Manufacturing Company, Seneca Falls, N. Y.; Albinson & Co., 2026 Fourteenth Street, Washington, D. C.;

Adam Weaber and Son, Vineland, N. J.; Rumsey & Co., Seneca Falls, N. Y.; Field Force Pump Company, Lockport, N. Y., or W. & B. Douglas, Middletown, Conn.

*When to Apply.*—As has been said, this question is of the first importance in dealing with any disease, but the answer varies with the case in hand. In general, however, let it be remembered that all treatment is preventive, that plants once attacked are lost, and that spraying must therefore be prompt and early. In the case of a disease of an herbaceous crop like potatoes, the first spraying should be given *at once* on the appearance of the disease in any part of the field or a neighboring field. The same applies to diseases of woody plants which have previously been free from disease; but where grapes or apples, for instance, were attacked last year, treatment should begin with the beginning of growth, and should proceed on the assumption that the disease will reappear if not prevented. In any case, after spraying is begun it must be repeated until danger is past, — a very variable period, — at intervals which may average ten days or two weeks, but will vary according to circumstances, depending especially on the amount of rainfall, which washes the copper salts from the plants and renders a new application necessary. It is always best to leave an occasional plant or row of plants untreated among the treated ones to furnish a basis for judgment as to the efficacy of the treatment.

*Quantities Needed.*—It is very difficult to give any statement of the amount of a fungicide required to properly spray any of the various plants on which it may be used.

The size and leaf surface of plants of the same kind vary so much with their age, the conditions of cultivation, and other controlling factors, that it is hardly possible to say what is an average plant of any sort. Besides this, very few experimenters have published statements as to the quantities used in their work. Yet one of the first questions asked by a beginner is, “How much do I need?”

With these facts understood, the following figures may be given as approximate statements of the amount of a preparation required for properly spraying the crops named, when a suitable and economical nozzle is used. For another plant

the amount can be roughly estimated by a comparison of its leaf surface with that of one of these ; For apple-trees, one and one-half to two gallons to a good-sized tree ; for grape-vines, one gallon to six or eight well-grown vines ; for potatoes, one hundred to one hundred and twenty-five gallons per acre.

*A Caution.* — Certain observations of the writer and certain well-known incidents in the fruit trade during the past season show that the use of fungicides, like every other good thing, may be carried to extremes by inexperienced or incautious beginners or by over-zealous friends. It is undeniably true that the free use of copper preparations has been recommended far too promiscuously and too inconsiderately in certain quarters for every fungous ill which vegetable "flesh is heir to." It is, or ought to be, self-evident that, on plants whose foliage is to be eaten, like lettuce, these preparations should *never* be used. On plants like the potato, which are cultivated for subterranean parts, their use is perfectly safe ; while to fruit-trees and vines the Bordeaux mixture, at least, should not be applied after the fruit has begun to ripen. If, from its nature or through favoring conditions, a disease makes its appearance after the fruit has begun to color, much can be done to prevent its spread by removal of diseased parts and rigid hygienic precautions. But, from the point of view of profit and loss alone, it is not worth while to save a crop to be seized by some vigilant board of health, which can afford to err only on the side of safety. Our present methods of treatment, while sufficient and unobjectionable for certain cases, must be regarded as only temporary and for the present better than nothing, in many other cases. For many diseases our only remedy yet known is quite as bad as the disease, and it is not to be expected that public sentiment will long tolerate the use of poisonous insecticides and fungicides where such use involves any possible danger.

*Some Experiences.* — The responses to the offers of assistance contained in this bulletin, while not so numerous as they should have been, were yet encouraging. They show that our most progressive farmers and gardeners are beginning to appreciate what this department is glad to do

for them. It is not known to what extent many of those who wrote for further information and advice practically applied it; but reports have been received from some which speak for themselves. Such is that of Mr. J. N. Pardee of South Billerica, who sprayed his apple trees only twice with Bordeaux mixture, containing Paris green, once on the 1st and once on the 13th of June. In each case the spraying was followed, the next day, by a heavy shower. Thinking the rains must have washed off the combined fungicide and insecticide, and that it was too late for further treatment to be effective, he did nothing more. Concerning results, he writes: "The fruit from the sprayed trees and parts of trees did not drop off as freely as from the unsprayed trees, and is uniformly fair, with clean, smooth skin, and two-thirds grade as choice No. 1, while the other third brings a good price as seconds. It is fair, but wormy. The fruit from the unsprayed trees and parts of trees is almost uniformly covered with black spots. The sound apples will not grade as first-class No. 1, while the wormy apples go for cider, and less than one-third of the fruit is sound. As all other conditions, soil, care, etc., have remained the same, I do not know what to attribute the difference to, except to the spraying. The cost of the material for the two sprayings was about fifteen cents per tree, and the time taken to spray thirty trees twice was about three hours for two men and a horse." It is evident that the secret of the efficacy of this slight treatment is to be found in the fact that it was applied at just the right time in the development of the fruit, and that the preparation was not washed off by the rains which immediately followed its application.

Mr. N. E. Baker of Lawrence has sprayed his carnations with the improved form of ammoniacal carbonate of copper both before and since putting them in the house, as a protection against the leaf-spot fungus (*Septoria Dianthi* Desm.), and reports that the new growth is vigorous and healthy.

These examples serve to show what may fairly be expected from the proper use of fungicides well applied, and it is hoped that they may encourage many others to try them next season. As a further stimulus in this direction it is

proposed to give annually in these reports special detailed instructions for the treatment of some group of diseases caused by fungi whose life histories are so similar that the same directions will apply to all. The symptoms of each disease and its effect on the diseased plants will be described, and enough of the life history of the parasite will be given to make clear the reasons for the treatment prescribed.

The group chosen for the present report is one of the best known as to the life history of its members, some of which are among the most easily avoided of all the fungi. It will, therefore, serve as an excellent introduction to the subject. Furthermore, the simplicity of the preventive treatment for some of these diseases will serve to tempt the reader to undertake it, and its striking efficacy will encourage the beginner to try the more laborious treatment for other troubles. The diseases in question are those known as SMUTS. (See Plate I.)

Of the large number of smut fungi which attack plants of all sorts, the number of those which are sources of loss to Massachusetts farmers to such an extent as to deserve mention here is five or six. They are those which cause the diseases known as the loose smuts of oats, barley and corn, and the leaf smuts of rye and of onions.

The loose smuts are peculiarly harmful, because the black smut-masses are formed only in the seeds or grains, the very part for which the plants are cultivated. These smuts of oats, barley and wheat have been regarded until lately as belonging to a single species known as *Ustilago segetum* (Bull.) Ditm.; but those who have studied them most carefully now consider that they include four species, distinguished by differences in spore germination, and by their restriction to particular hosts and their inability to attack others. They are called respectively *Ustilago Avenae* (Pers.), on oats, *U. Hordei* (Pers.) and *U. nuda*, (Jensen) K. & Sw., on barley, and *U. Tritici* (Pers.), on wheat. As the *oat smut* has been studied most and is best known, and is also perhaps the form which causes most loss in Massachusetts, it may be described here as a general type (Fig. 1.)

This fungus can penetrate only the very young tissues of its host plant, and is harmless to tissues whose outer cell walls have begun to harden. To be effective, the fungus-

threads must reach the growing tip of the host and develop with it; thus giving no sign of their presence until the plant is well grown and the heads are formed. But the growing point can only be reached when the very young seedling is attacked; therefore all attacks at a late period in the life of the host are soon overcome and outgrown. Now the tuft of hairs or "beard" and the "hulls" of the grain afford very convenient lodging places for smut spores, which are thus sown with the seed, germinate with it, and are ready to attack the young seedling at just the time when their attack is most effectual. Besides, these spores germinate most freely in fresh manure, and produce multitudes of germs which can attack the host plant under favorable circumstances. As it is probable that the spores can pass through the animal body unharmed, the manure from animals which have eaten smutted grain must be a very important source of infection. But it has been shown that the reproductive power of these germs becomes exhausted in the course of a year in manure; therefore old and well rotted manure, while otherwise better for the crop, is also harmless as a carrier of disease.

Professor Kellerman, formerly of the Kansas Agricultural College, has estimated that in Kansas the average annual loss of oats from this disease is equal to six or seven per cent. of the crop, and there is no reason to suppose that this estimate is too high for our own State. On the basis of the statistics of the United States Department of Agriculture this would give an annual loss in Massachusetts of \$20,000 from this single smut. Nearly the whole of this amount might very easily be saved, if our farmers would apply the very simple treatment which will certainly limit the disease to an occasional stalk. This consists in soaking the seed for fifteen minutes in hot water, kept at a temperature of 132° F., or for twenty-four hours in a solution of one pound of potassium sulphide (liver of sulphur) in twenty-four gallons of water. Neither of these treatments injures the seed, but, on the contrary, distinctly increases the crop.

Of the *barley smuts* (Fig. 2) one seems to yield readily to the same treatment, while the other seems not to be prevented by it; but, as both forms commonly occur on the

same field, at least a considerable decrease in the loss from smut may be expected to follow the treatment of barley with hot water before planting.

Wheat is not a crop of sufficient importance in Massachusetts to make any extended mention necessary here. It is subject not only to the loose smut mentioned above (Fig. 3), but also to the so-called hard or stinking smut or "Bunt" (*Tilletia* sp., Fig. 6). The latter of these is completely controlled by the hot-water treatment, but the former seems not to be affected by it.

A few practical directions for applying the hot-water treatment may be useful here. The seed should first be thoroughly wetted in cold water, and all imperfect seeds and other bodies which float on the top skimmed off. Two kettles of water should be provided, that in one at a temperature of 110° to 120°, and that in the other at the temperature required for the treatment, 132°. The latter should be kept as nearly as possible at the same temperature throughout the treatment, by the addition of hot or cold water whenever the thermometer shows it to be necessary. The seed is taken in lots of perhaps half a bushel at a time in a basket of wire gauze or a bag of very loosely woven material, and plunged first into the cooler water, lifted out and plunged again until it is thoroughly wetted and warmed. This is important, that the seed may not cool the hotter water too much. Now the basket or bag is transferred to the latter and allowed to remain fifteen minutes, during which it is occasionally lifted and lowered and turned about, to ensure the complete wetting of every grain. When the seed is removed it is quickly cooled with cold water and spread out until it is dry enough to be sown.

In the case of the *corn smut* it is not merely the young grains which are attacked, but the pustules may be found upon any part of the plant; and an infection of any part sufficiently young to be penetrated by the fungus gives rise in a few weeks to smut pustules. Thus the plant is not beyond liability to infection until all its tissues are hardened; that is, until the "tassel" appears.

The only treatment for this trouble which can be confidently recommended is the prompt removal and destruction

of all smutted parts as soon as they appear. It should hardly be necessary to call attention to the fact that to throw them into the compost heap is not to destroy them, but is often the surest means of perpetuating and disseminating the disease.

Fig. 5 shows a portion of a "tassel" of corn attacked by smut.

The *leaf-smut of rye* (Fig. 4) forms its black masses on the leaves and stems of rye, which are often considerably distorted by it. It does not, therefore, cause a direct loss of grain, but indirectly reduces the crop by weakening the plants which are attacked.

The same is true of the *onion smut*, which forms its pustules on both leaves and bulbs, and commonly kills its host. If the attack is not too severe, however, the plant may recover, though greatly weakened and never producing a strong bulb. It appears that only the young seedlings are susceptible to attack. This smut is propagated by means of the soil, and its spores may retain their vitality in the earth for several years. Treatment must consist in sowing with the onion seed some fungicidal substance which shall prevent the development of the smut spores in its vicinity, and the consequent infection of the seeding onions. The substance which gives most promise in this line at present is flowers of sulphur, although its protective effect is not all that can be desired. When a field becomes badly infected it should be used for some other crop, and the onion crop transferred to fresh ground for several years, at least.

For the assistance of any who may not feel certain as to the identify of the diseases here discussed, a plate is appended showing the characteristic appearance of the various smuts here mentioned, except that of onions. This plate was made from a photograph taken directly from specimens of diseased plants, and shows the effects of the various fungi on their respective host plants very clearly. With its help one should be able to identify the diseases represented without doubt.



## EXPLANATION OF PLATE I.

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### *Appearance of Some Smut Diseases.*

*(All figures of natural size.)*

- Fig. 1.** Loose Smut of Oats, *Ustilago Avenæ* (Pers.) Jens.
- Fig. 2.** Loose Smut of Barley, naked form, *U. nuda* (Jens.) Kell. & Sw.
- Fig. 3.** Loose Smut of Wheat, *U. Triticæ* (Pers.) Jens.
- Fig. 4.** Leaf Smut of Rye, *Urocystis occulta* (Wallr.) Rabh.
- Fig. 5.** Smut of Corn in the staminate flowers or "tassel," *Ustilago maydis* (DC.) Cda.
- Fig. 6.** Stinking Smut or "Bunt" of Wheat, *Tilletia foetens* (B. & C.) Trel.





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## PART III.

### SPECIAL WORK IN THE CHEMICAL LABORATORY.

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- I. COMMUNICATION ON COMMERCIAL FERTILIZERS:—
  - 1. GENERAL INTRODUCTION.
  - 2. LAWS FOR THE REGULATION OF TRADE IN COMMERCIAL FERTILIZERS.
  - 3. LIST OF LICENSED MANUFACTURERS FOR MAY 1, 1890, TO MAY 1, 1891.
  - 4. ANALYSES OF LICENSED FERTILIZERS.
  - 5. ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION.
  - 6. MISCELLANEOUS ANALYSES.
- II. WATER ANALYSES.
- III. COMPILATION OF ANALYSES MADE AT AMHERST, MASS., OF AGRICULTURAL CHEMICALS AND REFUSE MATERIALS USED FOR FERTILIZING PURPOSES.
- IV. COMPILATION OF ANALYSES MADE AT AMHERST, MASS., OF FODDER ARTICLES, FRUITS, SUGAR-PRODUCING PLANTS, DAIRY PRODUCTS, ETC.

## I. COMMUNICATION ON COMMERCIAL FERTILIZERS.

1. General introduction.
2. State laws for the regulation of the trade in commercial fertilizers.
3. List of licensed manufacturers and dealers for May 1, 1890, to May 1, 1891.
4. Analyses of licensed fertilizers.
5. Analyses of commercial fertilizers and manurial substances sent on for examination.
6. Miscellaneous analyses.

*1. General Introduction.*

The sale of commercial manurial substances, compound and simple, has been quite active in our State. Forty-eight manufacturers and dealers have applied and received a license for the sale of their various brands in our State. Twenty-six of them are residents of other States.

One hundred and ninety-two samples of licensed articles have been collected in all parts of the State by a duly authorized agent of the station. One hundred and fifty-eight of them have been carefully analyzed at the chemical laboratory of the station with the following results: six samples contained all three essential constituents above the highest guarantee; eighteen samples contained two of the essential constituents above the highest guarantee; forty-two samples contained one of the essential elements above the highest guarantee; sixty-one samples contained all three essential elements at the lowest guarantee; fifty samples contained two elements at the lowest guarantee; thirteen samples contained one element at the lowest guarantee; no samples contained all three essential elements below the stated lowest guarantee; nine samples contained two elements below the stated lowest guarantee; forty-two samples contained one element below the lowest stated guarantee.

The deficiency in one or two essential constituents was in the majority of instances compensated for by an excess in the others. The variations in the market price of the various prominent fertilizer constituents have been during the year within the usual limits. The most serious fluctuations were

noticed in case of Chili saltpetre, nitrate of sodium, with a slight advance for corresponding months.

The duties assigned to the director of the station, to act as inspector of commercial fertilizers, render it necessary to *discriminate* in official publications of the results of analyses of commercial fertilizers and of manurial substances in general made at the station, *between analyses of samples collected by a duly qualified delegate of the experiment station, in conformity with the rules prescribed by the new laws, and those analyses which are made of samples sent on for that purpose by outside parties.* In regard to the former alone can the director assume the responsibility of a carefully prepared sample, and of the identity of the article in question.

The official report of analyses of compound fertilizers and of all such materials as are to be used for manurial purposes, which are sold in this State under a certificate of compliance with the present laws for the regulation of the trade in these articles, has been restricted by our State laws to a statement of chemical composition and to such additional information as relates to the latter.

The practice of affixing to each analysis of this class of fertilizers an approximate commercial valuation per ton of their principal constituents has, therefore, been discontinued. This change, it is expected, will tend to direct the attention of the consumers of fertilizers more forcibly towards a *consideration of the particular composition of the different brands of fertilizers offered for their patronage, a circumstance not unfrequently overlooked.*

The *approximate market value* of the different brands of fertilizers obtained by the current mode of valuation does not express *their respective agricultural value*, i. e., their crop-producing value; for the higher or lower market price of different brands of fertilizers does not necessarily stand in a direct relation to their particular fitness, without any reference to the particular condition of the soil to be treated and the special wants of the crops to be raised by their assistance.

To select judiciously from among the various brands of fertilizers offered for patronage requires, in the main, two kinds of information; namely, we ought to feel confident

that the particular brand of fertilizer in question actually contains the guaranteed quantities and qualities of essential articles of plant food at a reasonable cost, and that it contains them in such form and such proportions as will best meet existing circumstances and special wants. In some cases it may be mainly either phosphoric acid or nitrogen or potash; in others, two of them; and in others again, all three. A remunerative use of commercial fertilizers can only be secured by attending carefully to the above-stated considerations.

To assist farmers not yet familiar with the current mode of determining the commercial value of manurial substances offered for sale in our markets, some of the essential considerations, which serve as a basis for their commercial valuation, are once more stated within a few subsequent pages.

The hitherto customary valuation of manurial substances is based on the average trade value of the essential fertilizing elements specified by analysis. The money value of the higher grades of agricultural chemicals and of the higher-priced compound fertilizers depends, in the majority of cases, on the amount and the particular form of two or three essential articles of plant food, i. e., phosphoric acid, nitrogen and potash, which they contain. To ascertain by this mode of valuation the approximate market value of a fertilizer (i. e., the money worth of its essential fertilizing ingredients), we multiply the pounds per ton of nitrogen, etc., by the trade value per pound; the same course is adopted with reference to the various forms of phosphoric acid and of potassium oxide. We thus get the values per ton of the several ingredients, and, adding them together, we obtain the total valuation per ton in case of cash payment at points of general distribution.

The market value of low-priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barn-yard manure, factory refuse and waste materials of different description, quite frequently does not stand in a close relation to the market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation, and

more or less advantageous mechanical condition for a speedy action, exert, as a rule, a decided influence on their selling price.

The mechanical condition of any fertilizing material, simple or compound, deserves the most serious consideration of farmers, when articles of a similar chemical character are offered for their choice. The degree of pulverization controls, almost without exception, under similar conditions, the rate of solubility, and the more or less rapid diffusion of the different articles of plant food throughout the soil.

The state of moisture exerts a no less important influence on the pecuniary value in case of one and the same kind of substance. Two samples of fish fertilizers, although equally pure, may differ from fifty to one hundred per cent. in commercial value, on account of mere difference in moisture.

Crude stock for the manufacture of fertilizers, and refuse materials of various descriptions, have to be valued with reference to the market price of their principal constituents, taking into consideration at the same time their general fitness for speedy action.

*Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals (1891).*

	Cents per Pound.
Nitrogen in ammoniates, . . . . .	18½
Nitrogen in nitrates,* . . . . .	14½
Organic nitrogen in dry and fine ground fish, meat, blood, . . . . .	15½
Organic nitrogen in cotton-seed meal and castor pomace, . . . . .	15
Organic nitrogen in fine-ground bone and tankage, . . . . .	15
Organic nitrogen in fine-ground medium bone and tankage, . . . . .	12
Organic nitrogen in medium bone and tankage, . . . . .	9½
Organic nitrogen in coarser bone and tankage, . . . . .	7½
Organic nitrogen in hair, horn shavings and coarse fish scraps, . . . . .	7
Phosphoric acid soluble in water, . . . . .	8
Phosphoric acid soluble in ammonium citrate, . . . . .	7½
Phosphoric acid in dry ground fish, fine bone and tankage, . . . . .	7
Phosphoric acid in fine medium bone and tankage, . . . . .	5½
Phosphoric acid in medium bone and tankage, . . . . .	4½
Phosphoric acid in coarse bone and tankage, . . . . .	3
Potash as high-grade sulphate, and in forms free from muriate or chlorides, ashes, etc., . . . . .	5½
Potash as kainite, . . . . .	4½
Potash as muriate, . . . . .	4½

\* The price of nitrate of soda has of late advanced, on account of the civil war in Chili.



The organic nitrogen in *superphosphates, special manures and mixed fertilizers of a high grade* is usually valued at the highest figures laid down in the trade values of fertilizing ingredients in raw materials, namely, fifteen and a half cents per pound; it being assumed that the organic nitrogen is derived from the best sources, viz., animal matter, as meat, blood, bones, or other equally good forms, and not from leather, shoddy, hair, or any low-priced, inferior form of vegetable matter, unless the contrary is ascertained. The insoluble phosphoric acid is valued in this connection at two cents.

The above trade values are the figures at which, in the six months preceding March, 1891, the respective ingredients could be bought at *retail for cash in our large markets, in the raw materials*, which are the regular source of supply.

They also correspond to the average wholesale prices for the six months ending March 1, plus about twenty per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to agree fairly with the retail price at the large markets of standard raw materials, such as:—

Sulphate of ammonia,	Dry ground fish,
Nitrate of soda,	Azotin,
Muriate of potash,	Ammonite,
Sulphate of potash,	Castor pomace,
Dried blood,	Bone and tankage,
Dried ground meat,	Plain superphosphates.

A large percentage of commercial materials consists of refuse matter from various industries. The composition of these substances depends on the mode of manufacture carried on. The rapid progress in our manufacturing industries is liable to affect at any time, more or less seriously, the composition of the refuse. To assist the farming community in a clear and intelligent appreciation of the various substances sold for manurial purposes, a frequent examination into the temporary characters of agricultural chemicals and refuse materials offered in our markets for manurial purposes is constantly carried on at the laboratory of the station.

Consumers of commercial manurial substances do well to

buy, whenever practicable, on guarantee of composition with reference to their essential constituents, and to see to it that the bill of sale recognizes that point of the bargain. Any mistake or misunderstanding in the transaction may be readily adjusted, in that case, between the contending parties. The responsibility of the dealer ends with furnishing an article corresponding in its composition with the lowest stated quantity of each specified essential constituent.

Our present laws for the regulation of the trade in commercial fertilizers include not only the various brands of compound fertilizers, but also all materials, single or compound, without reference to source, used for manurial purposes, when offered for sale in our market at ten dollars or more per ton. Copies of our present laws for the regulation of the trade in commercial fertilizers may be had by all interested, on application, at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.

2. *The Provisions of the Act are as follows:*

[CHAPTER 296.]

AN ACT TO REGULATE THE SALE OF COMMERCIAL FERTILIZERS.

*Be it enacted, etc., as follows:*

SECTION 1. Every lot or parcel of commercial fertilizer or material used for manurial purposes sold, offered or exposed for sale within this Commonwealth, the retail price of which is ten dollars or more per ton, shall be accompanied by a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand or trade mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the place of manufacture, and a chemical analysis stating the percentage of nitrogen or its equivalent in ammonia, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and reverted, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials, said label shall give a correct general statement of the composition and ingredients of the fertilizer it accompanies.

SECT. 2. Before any commercial fertilizer, the retail price of which is ten dollars or more per ton, is sold, offered or exposed for sale, the importer, manufacturer or party who causes it to be sold or offered for sale within the state of Massachusetts, shall

file with the director of the Massachusetts agricultural experiment station, a certified copy of the statement named in section one of this act, and shall also deposit with said director at his request a sealed glass jar or bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

SECT. 3. The manufacturer, importer, agent or seller of any brand of commercial fertilizer or material used for manurial purposes, the retail price of which is ten dollars or more per ton, shall pay for each brand, on or before the first day of May annually, to the director of the Massachusetts agricultural experiment station, an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus and potassium, contained or claimed to exist in said brand or fertilizer: *provided*, that whenever the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on receipt of said analysis fees and statement specified in section two, the director of said station shall issue certificates of compliance with this act.

SECT. 4. No person shall sell, offer or expose for sale in the state of Massachusetts, any pulverized leather, raw, steamed, roasted, or in any form as a fertilizer, or as an ingredient of any fertilizer or manure, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure and to accompany or go with every parcel or lot of the same.

SECT. 5. Any person selling, offering or exposing for sale, any commercial fertilizer without the statement required by the first section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence, and one hundred dollars for each subsequent offence.

SECT. 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use, and not to sell in this state.

SECT. 7. The director of the Massachusetts agricultural experiment station shall pay the analysis fees, as soon as received by him, into the treasury of the station, and shall cause one analysis or more of each fertilizer or material used for manurial purposes to be made annually, and publish the results monthly, with such

additional information as circumstances advise: *provided*, such information relates only to the composition of the fertilizer or fertilizing material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or any material used for manurial purposes which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest or their representative, and taken from a parcel or a number of packages which shall be not less than ten per cent. of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn and the time and place of drawing, and said label shall also be signed by the director or his deputy and by the party or parties in interest or their representatives present at the drawing and sealing of said sample; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled. All parties violating this act shall be prosecuted by the director of said station; but it shall be the duty of said director, upon ascertaining any violation of this act, to forthwith notify the manufacturer or importer in writing, and give him not less than thirty days thereafter in which to comply with the requirements of this act, but there shall be no prosecution in relation to the quality of the fertilizer or fertilizing material if the same shall be found substantially equivalent to the statement of analysis made by the manufacturer or importer.

SECT. 8. Sections eleven to sixteen inclusive of chapter sixty of the Public Statutes are hereby repealed.

SECT. 9. This act shall take effect on the first day of September in the year eighteen hundred and eighty-eight. [*Approved May 3, 1888.*]

*Instructions to Manufacturers, Importers, Agents and Sellers of Commercial Fertilizers or Materials Used for Manurial Purposes in Massachusetts.*

1. An application for a certificate of compliance with the regulations of the trade in commercial fertilizers and materials used for manurial purposes in this State must be accompanied: —

*First*, with a distinct statement of the name of each brand offered for sale.

*Second*, with a statement of the amount of phosphoric acid, of nitrogen and of potassium oxide guaranteed in each distinct brand.

*Third*, with the fee charged by the State for a certificate, which is five dollars for each of the following articles: nitrogen, phosphoric acid and potassium oxide guaranteed in any distinct brand.

2. The obligation to secure a certificate applies not only to compound fertilizers but to all substances, single or compound, used for manurial purposes, and offered for sale at ten dollars or more per ton of two thousand pounds.

3. The certificate must be secured annually before the first of May.

4. Manufacturers, importers and dealers in commercial fertilizers can appoint in this State as many agents as they desire, after having secured at this office the certificate of compliance with our laws.

5. Agents of manufacturers, importers and dealers in commercial fertilizers are held personally responsible for their transactions until they can prove that the articles they offer for sale are duly recorded in this office.

6. Manufacturers and importers are requested to furnish a list of their agents.

7. All applications for certificates ought to be addressed to the Director of the Massachusetts State Agricultural Experiment Station.

Arrangements are made, as in previous years, to attend to the examination of objects of general interest to the farming community, to the full extent of existing resources. Requests for analyses of substances—as fodder articles, fertilizers, etc.—coming through officers of agricultural societies and farmers' clubs within the State will receive hereafter, as in the past, first attention, and in the order that the applications arrive at the office of the station. The results will be returned without a charge for the services rendered. Application of private parties for analyses of substances, free of charge, will receive a careful consideration whenever the results promise to be of a more general interest. For obvious reasons, no work can be carried on at the station of which the results are not at the disposal of the managers for

publication, if deemed advisable in the interest of the citizens of the State.

All parcels and communications sent to "The Massachusetts State Experiment Station" must have express and postal charges prepaid, to receive attention.

*3. List of Dealers who have secured Certificates for the Sale of Commercial Fertilizers in this State during the Past Year, and the Brands licensed by Each.*

Ames Fertilizer Company, Peabody, Mass.:—  
Animal Fertilizer.

E. Frank Coe, New York, N. Y.:—  
High-grade Ammoniated Bone Superphosphate.  
Gold Brand Excelsior Guano.  
Potato Fertilizer.  
Blue Brand Excelsior Guano.  
Red Brand Excelsior Guano,

Cleveland Linseed Company, Worcester, Mass.:—  
Steam-cooked Linseed Meal.

H. J. Baker & Bro., New York, N. Y.:—  
A. A. Ammoniated Superphosphate.  
Pelican Bone Fertilizer.  
Special Potato Manure.  
Special Grass Manure.

Whittemore Bros., Wayland, Mass.:—  
Whittemore's Complete Manure.

J. M. Butman, Lowell, Mass.:—  
Lowell Bone Fertilizer.

Edmund Hersey, Hingham, Mass.:—  
Ground Bone.

J. A. Tucker & Co., Boston, Mass.:—  
Original Bay State Bone Superphosphate.  
Imperial Bone Superphosphate.

J. C. Dow & Co., Boston, Mass.:—  
Nitrogenous Superphosphate.  
Ground Bone Fertilizer.  
Fine-ground Bone.

Cumberland Bone Company, Portland, Me.:—  
Cumberland Bone Superphosphate.  
Seeding-down Fertilizer.  
Potato Fertilizer.

3. *List of Dealers who have secured Certificates, etc.* — Continued.

C. A. Bartlett, Worcester, Mass. : —

Pure Ground Bone.

Animal Fertilizer.

Leander Wilcox, Mystic Bridge, Conn. : —

Dry Ground Fish Guano.

Potato Manure.

Ammoniated Bone Superphosphate.

High-grade Fish and Potash.

W. E. Fyfe & Co., Clinton, Mass. : —

Unleached Wood Ashes.

Daniel T. Church, Tiverton, R. I. : —

Fish and Potash.

Church's Special.

Church's Standard.

Pure Dry Ground Menhaden Guano.

Williams & Clark Fertilizer Company, Boston, Mass. : —

Americus Superphosphate.

Potato Phosphate.

Bone Meal.

High-grade Special.

Tobacco Grower.

Sulphate of Potash.

Muriate of Potash.

Dry Ground Fish.

Cleveland Dryer Company, Boston, Mass. : —

Cleveland Potato Phosphate.

Cleveland Superphosphate.

W. D. Stewart & Co., Boston, Mass. : —

Soluble Pacific Guano.

Special Potato Manure.

Munroe, Judson & Stroup, Oswego, N. Y. : —

Unleached Canada Wood Ashes.

N. Ward Company, Boston, Mass. : —

High-grade Animal Fertilizer.

Lister's Agricultural Chemical Works, Newark, N. J. : —

Standard Fertilizer, Success.

Ammoniated Dissolved Bone Phosphate.

Potato Fertilizer.

Ground Bone.

*3. List of Dealers who have secured Certificates, etc. — Continued.*

G. E. Holmes, Worcester, Mass. : —  
Steamed Bone.

A. Lee & Co., Boston, Mass. : —  
Lawrence Fertilizer.  
Ground Bone.

Crocker Fertilizer and Chemical Company, Buffalo, N. Y. : —  
New Rival Ammoniated Superphosphate.  
Buffalo Superphosphate, No. 2.  
Special Potato Manure.  
Pure Ground Bone.  
Ammoniated Bone Superphosphate.  
Potato, Hop and Tobacco Phosphate.  
Queen City Phosphate.  
Vegetable Bone Superphosphate.  
Wheat and Corn Phosphate.  
Niagara Phosphate.  
Ammoniated Practical Phosphate.

F. C. Sturtevant, Hartford, Conn. : —  
Tobacco and Sulphur Fertilizer.

Read Fertilizer Company, Syracuse, N. Y. : —  
H. G. Farmers' Friend.  
Standard Phosphate.  
Bone, Fish and Potash.  
Strawberry and Small Fruit Special.

Bradley Fertilizer Company, Boston, Mass. : —  
X. L. Phosphate.  
B. D. Sea-fowl Guano.  
Coe's Original Superphosphate of Lime.  
Fish and Potash.  
Pure Fine-ground Bone.  
Bradley's Complete Manures : —  
For Potatoes and Vegetables.  
For Corn and Grain.  
For Top-dressing Grass and Grain.  
Bradley's Potato Manure.  
Nitrate of Soda.  
Sulphate of Ammonia.  
Muriate of Potash.  
Dissolved Bone-black.



3. *List of Dealers who have secured Certificates, etc.* — Continued.

Quinnipiac Fertilizer Company, New London, Conn. : —

Quinnipiac Phosphate.  
Quinnipiac Potato Manure.  
Quinnipiac Dry Ground Fish.  
Quinnipiac Fish and Potash.  
Quinnipiac Market-garden Manure.  
Quinnipiac Bone Meal.  
Quinnipiac Tobacco Fertilizer.  
Muriate of Potash.  
Sulphate of Potash.

Standard Fertilizer Company, Boston, Mass. : —

Standard Fertilizer.  
Standard Superphosphate.

Sanford Winter, Brockton, Mass. : —

Pure Ground Bone.

Forest City Wood Ash Company, London, Ont. : —

Unleached Wood Ashes.

Benjamin Randall, East Boston, Mass. : —

Market-garden Fertilizer.  
Standard Ground Bone.

Great Eastern Fertilizer Company, Rutland, Vt. : —

Great Eastern General, for Grain and Grass.  
Great Eastern Vegetable, Vine and Tobacco Fertilizers.  
Great Eastern General, Oats, Buckwheat and Seeding-down  
Phosphate.

E. H. Smith, Northborough, Mass. : —

Steamed Bone.

John G. Jefferds, Worcester, Mass. : —

Jefferds' Animal Fertilizer.  
Jefferds' Fine-ground Bone.

James E. McGovern, Lawrence, Mass. : —

West Andover Market Bone Phosphate.  
Fine-ground Bone.

Thos. Hersom & Co., New Bedford, Mass. : —

Meat and Bone.  
Pure Fine-ground Bone.

**3. *List of Dealers who have secured Certificates, etc.* — Continued.**

**Adams & Thomas, Springfield, Mass. : —**

Adams' Market Bone Fertilizer.

**Hargrave Manufacturing Company, Fall River, Mass. : —**

Steamed Bone.

**Mapes Formula and Peruvian Guano Company, New York,  
N. Y. : —**

The Mapes Bone Manures.

Peruvian Guano.

Mapes Superphosphate.

Mapes Special Crop Manures.

**L. B. Darling Fertilizer Company, Pawtucket, R. I. : —**

Darling's Animal Fertilizer.

Extra Bone Phosphate.

Potato and Root Crop Manure.

Fine Bone.

Dissolved Bone.

Fertilizer for Lawns and Gardens.

**Bowker Fertilizer Company, Boston, Mass. : —**

Stockbridge Manures.

Hill and Drill Phosphate.

Lawn and Garden Phosphate.

Ammoniated Bone Fertilizer.

Fish and Potash.

Dry Ground Fish.

Gloucester Fish and Potash.

Fresh Ground Bone.

Plain Superphosphate.

Kainite.

Nitrate of Soda.

Dried Blood.

Dissolved Bone-black.

Muriate of Potash.

Sulphate of Potash.

Breck's Lawn and Garden Dressing.

**Lucien Sanderson, New Haven, Conn. : —**

Formula A.

Pulverized Bone Meal.

Dissolved Bone-black.

Sulphate of Potash.

3. *List of Dealers who have secured Certificates, etc.* — Concluded.

Prentiss, Brooks & Co., Holyoke, Mass. : —

H. L. Phelps' Complete Manures.

Dry Fish.

Muriate of Potash.

Nitrate of Soda.

Dissolved Bone-black.

H. L. Phelps' Superphosphate.

Fish and Potash.

Guano and Potash.

Tankage.

The Le Page Company, Boston, Mass. : —

Red Star Brand 203 Fertilizer.

Red Star Brand Special Potato Manure.

John S. Reese & Co., Baltimore, Md. : —

Bay State Fertilizer.

New England Favorite.

Bay State Fertilizer, G. G.

May Flower Guano.

Pilgrim Fertilizer.

Great Planet, A.

Columbus, A.

Potato and Corn.

Fish and Potash.

Dry Ground Fish.

Thomas Joynt, St. Helens, Ont. : —

Canada Hardwood Ashes.

National Fertilizer Company, Bridgeport, Conn. : —

Chittenden's Complete Fertilizer.

Chittenden's Fish and Potash.

Chittenden's Universal Phosphate.

Ground Bone.

W. J. Brightman & Co., Tiverton, R. I. : —

Fish and Potash.

Ground Acidulated Fish Guano.

Ammoniated Bone Superphosphate.

4. *Analyses of Commercial Fertilizers collected during 1891, in the General Markets, by the Agent of the Massachusetts Agricultural Experiment Station.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	<i>Compound Fertilizers.</i>		
1	Animal Fertilizer, . . . . .	C. A. Bartlett, Worcester, Mass., . . . . .	Worcester.
5	Mapes Manure for Corn, . . . . .	Mapes Formula and Peruvian Guano Company, New York, . . . . .	Northampton.
6	Mapes Manure for Tobacco, . . . . .	Mapes Formula and Peruvian Guano Company, New York, . . . . .	Northampton.
7	Mapes Manure for Potatoes, . . . . .	Mapes Formula and Peruvian Guano Company, New York, . . . . .	Northampton.
11	Stockbridge's Manure for Onions, . . . . .	Bowker Fertilizer Company, Boston, Mass., . . . . .	Northampton.
12	Stockbridge's Manure for Potatoes and Vegetables, . . . . .	Bowker Fertilizer Company, Boston, Mass., . . . . .	Springfield.
13	Bradley's X. L. Superphosphate, . . . . .	Bradley Fertilizer Company, Boston, Mass., . . . . .	Springfield.
16	Bradley's Potato Manure, . . . . .	Bradley Fertilizer Company, Boston, Mass., . . . . .	Springfield.
18	Adams' Market Bone Fertilizer, . . . . .	Adams & Thomas, Springfield, Mass., . . . . .	Springfield.
19	Quinnipiac Phosphate, . . . . .	The Quinnipiac Company, Boston, Mass., . . . . .	Northampton.
20	Quinnipiac Fish and Potash (crossed fish brand), . . . . .	The Quinnipiac Company, Boston, Mass., . . . . .	Northampton.
26	Quinnipiac Dry Ground Fish, . . . . .	The Quinnipiac Company, Boston, Mass., . . . . .	Hatfield.
36	Lowell Bone Fertilizer, . . . . .	J. M. Butman, Chelmsford, Mass., . . . . .	Chelmsford.
37	Animal Fertilizer, . . . . .	Ames Fertilizer Company, Peabody, Mass., . . . . .	West Acton.
38	Chittenden's Complete Fertilizer for Potatoes, Roots and Vegetables, . . . . .	National Fertilizer Company, Bridgeport, Conn., . . . . .	West Acton.
	<i>Bones.</i>		
2	Pure Ground Bone, . . . . .	C. A. Bartlett, Worcester, Mass., . . . . .	Worcester.
3	Jefferts' Fine-ground Bone, . . . . .	John G. Jefferts, Worcester, Mass., . . . . .	Worcester.
4	Fine-ground Bone, . . . . .	Gilbert E. Holmes, Worcester, Mass., . . . . .	Worcester.
33	Bowker's Fresh Ground Bone, . . . . .	Bowker Fertilizer Company, Boston, Mass., . . . . .	Concord.
40	Chittenden's Ground Bone, . . . . .	National Fertilizer Company, Bridgeport, Conn., . . . . .	West Acton.
52	Ground Bone, . . . . .	Edmund Horsey, Hingham, Mass., . . . . .	Hingham.
59	Steamed Bone, . . . . .	E. H. Smith, Northborough, Mass., . . . . .	Amherst.

## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.					POTASSIUM OXIDE IN ONE HUNDRED POUNDS.		
		Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	TOTAL.		Found.	Guaranteed.	
							Round.	Guaran- teed.			
<i>Compound Fertilizers.</i>											
1	Animal Fertilizer, Corn.	5.06	3.3—4.12	.50	8.29	4.25	13.04	16—18	8.79	7.99	7—8
5	Mapes Manure for Corn.	3.60	3.71—4.12	4.99	4.68	.83	10.50	10—12	9.67	6.53	6—7
6	Mapes Manure for Tobacco.	6.64	6.18	.78	3.13	1.96	6.87	4.5	7.91	10.21	10.50*
7	Mapes Manure for Potatoes.	3.66	3.71—4.12	6.78	1.13	1.43	9.34	8—10	7.91	7.80	6—8*
11	Stockbridge's Manure for Potatoes.	3.10	3—4	4.11	5.32	1.61	11.04	8—10	9.43	6.75	6—8
12	Stockbridge's Manure for Potatoes and Vegetables.	3.48	3.25—4.25	4.72	4.68	2.06	11.46	8—10	9.40	6.48	6—8
16	Bradley's X. L. Superphosphate.	2.83	2.5—3.25	7.42	2.54	1.75	11.71	11—14	9.96	6.8	2—3*
17	Bradley's Potato Manure.	4.29	2.5—3.25	4.34	6.42	2.34	12.10	8—11	9.78	4.30	6—6*
18	Adams' Market Bone Fertilizer.	10.02	4.49	2.5—3.5	.61	6.46	3.90	10.87	7.07	4.86	3—5
19	Quinnipiac Phosphate.	14.15	2.95	2.47—3.3	5.53	1.02	11.22	10—15	10.20	2.41	2—3
20	Quinnipiac Fish and Potash (crossed fish brand).	20.16	3.60	3.43—4.12	2.23	2.23	8.64	5—9	2.46	4.82	4—6*
26	Quinnipiac Dry Ground Fish.	9.26	8.60	7.41—9.06	.26	3.01	7.43	7—9	3.27	2.94	2—3.5
36	Lowell Bone Fertilizer.	13.23	2.46	2—2.5	6.17	3.74	11.00	10—16.5	9.95	3.22	2.75—3.5
37	Animal Fertilizer.	16.68	3.35	3.3—4.12	5.68	.40	10.02	9—12	9.62	6.98	6—8
38	Chittenden's Complete Fertilizer for Potatoes, Roots and Vegetables.	14.76	3.42	3.3—4.12	4.82	2.72	10.94	8—10	8.22		
<i>MECHANICAL ANALYSIS.</i>											

\* Sulphate of potash, the source of potash.

## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	<i>Compound Fertilizers.</i>		
28	Bowker's Hill and Drill Phosphate.	Bowker Fertilizer Company, Boston, Mass.,	Littleton.
35	Dow's Nitrogenous Superphosphate.	John C. Dow & Co., Boston, Mass.,	South Acton.
38	Chittenden's Ammoniated Bone Superphosphate.	National Fertilizer Company, Bridgeport, Conn.,	West Acton.
41	Original Bay State Bone Superphosphate.	J. A. Tucker & Co., Boston, Mass.,	Framingham.
42	Tobacco and Sulphur Lawn Fertilizer.	F. C. Sturtevant, Hartford, Conn.,	Concord.
46	Crocker's Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Framingham.
50	Cumberland Superphosphate.	Cumberland Bone Company, Portland, Me.,	West Acton.
60	Williams & Clark Fertilizer Company's Potato Phosphate.	Williams & Clark Fertilizer Company, Boston, Mass.,	Springfield.
72	Church's Fish and Potash (D brand).	Joseph Church & Co., Tiverton, R. I.,	Springfield.
74	Complete Potato Manure.	H. J. Baker & Bro., New York, N. Y.,	Pittsfield.
78	Great Eastern Vegetable, Vine and Tobacco Fertilizer.	Great Eastern Fertilizer Company, Rutland, Vt.,	Lee.
79	E. Frank Coe's High-grade Ammoniated Bone Superphosphate.	E. Frank Coe, New York, N. Y.,	Pittsfield.
83	Pilgrim Fertilizer.	John S. Reese & Co., Baltimore, Md.,	Hadley.
95	Pulverized Meat and Bone.	Lucien Sanderson, New Haven, Conn.,	Sunderland.
104	Soluble Pacific Guano.	W. D. Stewart, Boston, Mass.,	Sunderland.
107	Bradley's High-grade Tobacco Manure.	Bradley Fertilizer Company, Boston, Mass.,	South Deerfield.
109	Cleveland Potato Phosphate.	Cleveland Dryer Company, Boston, Mass.,	Barre Plains.
114	Pilgrim Fertilizer.	John S. Reese & Co., Baltimore, Md.,	Barre Plains.
115	Soluble Pacific Guano.	W. D. Stewart, Boston, Mass.,	Fall River.
127	Brighman & Co.'s Dry Ground Menhaden Fish Guano.	Wm. J. Brighman & Co., Tiverton, R. I.,	New Bedford.
130	Meat and Bone.	Thos. Hersom & Co., New Bedford, Mass.,	New Bedford.
132	Tobacco and Sulphur Lawn Fertilizer.	F. C. Sturtevant, Hartford, Conn.,	Wayland.
139	Whitemore's Complete Manure.	Whitemore Bros., Wayland, Mass.,	Saxtonville.
140	Standard Fertilizer.	Standard Fertilizer Company, Boston, Mass.,	Taunton.
145	Church's Fish and Potash (D brand).	Joseph Church & Co., Tiverton, R. I.,	

## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	Moisture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.				AVAILABLE.		Found.	Guaranteed.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	TOTAL.					
								Found.	Guaran- teed.				
<i>Compound Fertilizers.</i>													
28	Bowker's Hill and Drill Phosphate.	15.52	2.83	2.5—3.25	6.15	2.88	2.57	11.60	12—14	9.03	8—10	2.14	2—3
35	Dow's Nitrogenous Superphosphate.	16.48	2.34	2.06—2.88	3.97	5.17	2.32	11.46	—	9.14	8—10	3.14	3—4
39	Chittenden's Ammoniated Bone Superphosphate.	20.55	2.14	1.65—2.47	6.37	2.56	1.69	10.62	9—11	8.93	7—9	2.96	2—4
41	Original Bay State Bone Superphosphate.	19.06	2.66	2.47—2.88	.91	6.78	3.30	10.99	10—12	7.66	9—9.5	2.78	2—3
42	Tobacco and Sulphur Lawn Fertilizer.	17.17	1.76	1.96	—	—	—	.81	.75	—	—	8.06	7.66
132	Crocker's Ammoniated Wheat and Corn Phos.	17.25	8.12	2—3	5.56	5.36	4.14	15.06	—	10.92	10—13	3.10	1.75—2.92*
46	Chamberland Superphosphate.	16.20	3.20	2—3	4.82	5.60	3.88	14.10	12—14	10.22	9—12	3.14	2—3
50	Williams & Clark Fertilizer Co.'s Potato Phos.	13.68	3.24	2.47—3.30	5.82	.78	2.65	8.85	—	6.20	6—9	5.55	5—8*
72	Church's Fish and Potash (D brand).	25.11	4.28	3.30—4.12	.84	4.30	1.05	6.19	5—6	5.14	—	4.32	3—4
145	Complete Potato Manure.	11.52	3.40	3.30	4.44	2.38	1.24	8.06	—	6.82	5—75	11.34	10
78	Great Eastern Vegetable, Vine and Tob. Fer.	17.00	2.10	2.06—2.88	5.84	2.21	1.93	10.08	—	8.15	8—12	6.48	6—8
79	Coe's High-grade Ammoniated Bone Sup'ph.	15.39	2.50	2—2.5	7.68	2.50	2.20	12.83	11—13	10.18	9—12	2.08	2*
89	Pilgrim Fertilizer.	7.56	1.56	1—1.45	3.70	5.20	1.77	10.67	7.5—11.5	8.90	6.5—6.5	3.51	2.5—3.5
114	Pulverized Meat and Bone.	1.95	5.85	4.94—5.77	.77	8.85	7.70	17.32	18—20	9.62	—	—	—
104	Soluble Pacific Guano.	16.27	3.00	2.25—3	7.22	2.68	2.02	11.92	10.5—16	9.90	8.5—12	4.64	3.70—6.50
115	Bradley's High-grade Tobacco Manure.	9.06	5.46	5.77—6.59	1.43	3.04	2.05	6.52	4—5	4.47	8—10	9.62	10.80—12.40*
107	Cleveland Potato Phosphate.	18.31	2.37	2.05—2.85	7.19	2.18	2.09	11.46	—	9.37	—	3.66	3.20—4.25*
137	Brighman & Company's Dry Gr. Men. F. G.	10.51	7.96	8.24—9.89	1.15	3.43	3.77	8.35	6.87—9.16	4.53	—	—	—
130	Meat and Bone.	4.81	4.48	4.24	.38	6.85	11.55	18.78	19.52	7.23	6—73	—	—
120	Whittemore's Complete Manure.	15.90	2.58	2.47—3.30	4.41	8.45	3.28	16.14	18—14	12.86	8—12	4.68	3—4
140	Standard Fertilizer.	17.23	2.95	2—3	7.00	4.90	1.84	13.74	10—15	11.90	8—12	3.19	2—3*

\* Sulphate of potash, the source of potash.

## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	<i>Compound Fertilizers.</i>		
48	Bone Superphosphate for Vegetables,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Framingham.
54	Bowler's Bone-black,	Bowler Fertilizer Company, Boston, Mass.,	Amherst.
61	Ammoniated Bone Superphosphate (Americus Brand),	Williams & Clark Fertilizer Company, Boston, Mass.,	Springfield.
67	The H. L. Phelps Superphosphate,	Prentiss, Brooke & Co., Holyoke, Mass.,	Holyoke.
75	A. A. Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
92	Dissolved Bone-black,	Lucien Sanders, New Haven, Conn.,	Hadley.
99	Wilcox Potato Manure,	Leander Wilcox, Mystic, Conn.,	Amherst.
123	Darling's Animal Fertilizer,	Darling Fertilizer Co., Pawtucket, R. I.,	Worcester.
133	Flash and Potash,	John S. Reese & Co., Baltimore, Md.,	Dighton.
147	Strawberry Special,	Benj. Randall, East Boston, Mass.,	New Bedford.
150	Randall's Market-garden Fertilizer,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	East Boston.
155	Vegetable Bone Superphosphate,	Le Page Company, Boston, Mass.,	Boston.
156	Red Star Brand Special Fertilizer for Potatoes, Cabbages, etc.,	Lister Agricultural and Chemical Works, Newark, N. J.,	Newburyport.
162	Red Star Brand Special Fertilizer for Potatoes, Cabbages, etc.,	Lister Agricultural and Chemical Works, Newark, N. J.,	Lowell.
177	Huanillos Peruvian Guano,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Boston.
185	Flash and Potash,	Read Fertilizer Company, Syracuse, N. Y.,	Boston.
190	Lister's Ammoniated Dissolved Bone,	Lister Agricultural and Chemical Works, Newark, N. J.,	Northampton.
	<i>Bones.</i>		
62	Fine Pure Ground Bone,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
117	Pure Ground Bone,	Harrgrave Manufacturing Company, Fall River, Mass.,	Fall River.
167	Lavery's Pure Ground Bone,	William Lavery, Amesbury, Mass.,	Amesbury.
170	West Andover Ground Bone,	James E. McGovern, Lawrence, Mass.,	Lawrence.
181	S. Winter's Pure Ground Bone,	Sanford Winter, Brockton, Mass.,	Brockton.



## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	NITROGEN IN ONE HUNDRED POUNDS.		Soluble.	Reverted.	Insoluble.	TOTAL.		AVAILABLE.		POTASSIUM OXIDE IN ONE HUNDRED POUNDS.	
		Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
48	<i>Compound Fertilizer.</i>											
155	Bone Superphosphate for Vegetables, . .	11.64	5.52	5-5	3.42	4.11	1.30	8.83	7.53	6-7	6.72	6-8*
54	Bowker's Bone-black, . .	18.64	-	-	13.43	2.38	.59	16.40	16.81	15-18	-	-
61	Americus Brand Ammon. Bone Superphosphate, .	14.42	2.68	2.47-3.30	7.77	1.75	2.46	11.98	9.62	9-11	1.90	2-3*
67	The H. L. Phelps Superphosphate, .	15.72	2.62	2.47-3.30	9.11	-	1.75	9.86	9.11	8-10	3.25	3-4
75	A. A. Ammoniated Superphosphate, .	8.01	3.86	2.47-3.30	8.12	.27	1.10	9.49	8.39	10-12	2.03	2-3
92	Dissolved Bone-black, . .	17.30	-	-	15.94	.51	.46	16.91	16.45	16-18	-	-
99	Wilcox Potato Manure, . .	20.61	3.82	3.25-4.25	5.23	1.77	.52	7.52	7.00	7-8	6.10	6-7
123	Darling's Animal Fertilizer, . .	15.82	3.40	3.30-4.94	3.39	3.04	4.89	11.32	6.43	-	4.28	4-6
133	Strawberry Special, . .	17.50	3.62	3.30-4.94	3.61	1.49	2.10	7.20	6.8	5-6	6.80	6-8*
147	Fish and Potash, . .	14.04	4.00	2.47-4.11	6.79	2.70	1.54	11.03	10.10	6.5-8	4.64	3-5
150	Red Star Brand Special Fertilizer for Potatoes, etc.,	22.40	3.92	1.45-2.88	7.06	5.83	.82	11.71	10.59	8-11	2.09	2-4
156	Randall's Market-garden Fertilizer, . .	16.05	3.98	3-4	5.26	2.39	1.45	9.10	8-10	6-8	5.80	5-6*
162	Lister's Success Standard Fertilizer, . .	21.86	1.89	.91-1.65	8.32	2.11	1.07	11.50	10.5-12	-	1.53	1.5-2*
177	Huanillos Peruvian Guano, . .	14.63	1.18	1.68	.18	4.65	21.57	26.40	4.83	-	.25	.29
185	Fish and Potash, . .	19.31	2.60	2.47-3.30	3.36	.89	1.38	5.63	4.25	4-5	4.48	4-5*
190	Lister's Ammoniated Dissolved Bone, . .	11.89	2.48	1.81-2.06	6.67	2.18	5.35	14.20	8.58	9-10	1.69	2-3*
MECHANICAL ANALYSIS.												
		Fine.	Medium.	Medium.	Coarse.							
62	<i>Bones.</i>											
117	Fine Pure Ground Bone, . .	10.03	3.34	3.30-3.61	-	2.37	21.62	23.97	2.35	-	.03	10.79
167	Pure Ground Bone, . .	6.69	2.88	2.50-2.80	.67	13.75	10.69	25.13	14.44	-	36.37	22.23
170	Lavery's Pure Ground Bone, .	9.25	2.52	-	.18	9.16	6.97	16.31	9.34	-	47.05	32.38
181	West Andover Ground Bone, .	10.24	2.02	-	-	12.76	10.59	23.35	12.76	-	63.20	26.60
181	S. Winder's Pure Ground Bone, .	8.07	2.56	8.16	.45	12.26	18.29	26.00	13.71	11.28	53.72	26.35
												15.73
												4.20

\* Sulphate of potash, the source of potash.

## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at—
	<i>Compound Fertilizers.</i>		
66	Fish and Potash, . . . . .	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
69	Tankage, . . . . .	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
77	New Rival Ammoniated Superphosphate, . . . . .	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Pittsfield.
84	Extra Fine-ground Bone with Potash (circle brand), . . . . .	Bradley Fertilizer Company, Boston, Mass.,	Pittsfield.
89	Reese's May Flower Guano, . . . . .	John S. Reese & Co., Baltimore, Md.,	Hedley.
93	Blood, Meat and Bone, . . . . .	Lucien Sanderson, New Haven, Conn.,	Amherst.
102	Wilcox's Dry Ground Fish Guano, . . . . .	Leander Wilcox, Mystic, Conn.,	South Deerfield.
112	Blue Brand Excelsior Guano, . . . . .	E. Frank Cox, New York, N. Y.,	Barns Plains.
122	Reese's May Flower, . . . . .	John S. Reese & Co., Baltimore, Md.,	Fall River.
124	Complete Grass Manure, . . . . .	H. J. Baker & Bro., New York, N. Y.,	Taunton.
128	Fish Pomace, . . . . .	W. J. Brightman & Co., Taunton, R. I.,	Fall River.
138	Quinnipiac Market Garden Fertilizer, . . . . .	The Quinnipiac Company, Boston, Mass.,	New Bedford.
148	Dry Ground Fish, . . . . .	John S. Reese & Co., Baltimore, Md.,	Woburn.
166	Bowker's Lawn and Garden Dressing, . . . . .	Bowker Fertilizer Company, Boston, Mass.,	Boston.
172	Dow's Ground Bone Fertilizer, . . . . .	John C. Dow & Co., Boston, Mass.,	Boston.
173	Standard Guano, . . . . .	Standard Fertilizer Company, Boston, Mass.,	Greenfield.
186	B. D. Sea Fowl Guano, . . . . .	Bradley Fertilizer Company, Boston, Mass.,	
	<i>Bones.</i>		
80	Pure Ground Bone, . . . . .	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Lee.
86	Quinnipiac Pure Bone Meal, . . . . .	The Quinnipiac Company, Boston, Mass.,	Williamstown.
91	Quinnipiac Pure Bone Meal, . . . . .	The Quinnipiac Company, Boston, Mass.,	Springfield.
131	Pure Fine-ground Bone, . . . . .	Thos. Hersom & Co., New Bedford, Mass.,	New Bedford.
151	Standard Ground Bone, . . . . .	Benj. Randall, East Boston, Mass.,	East Boston.
154	Pure Ground Bone, . . . . .	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Newburyport.
161	Lister's Celebrated Ground Bone, . . . . .	Lister Agricultural and Chemical Works, Newark, N. J.,	Lowell.
192	Dow's Ground Bone, . . . . .	John C. Dow & Co., Boston, Mass.,	

#### 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.						POTASSIUM OXIDE IN ONE HUNDRED POUNDS.			
		Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	
Compound Fertilizers.													
66	Fish and Potash.	9.91	3.30-4.12	1.46	2.15	1.97	6.58	5-8	3.61	-	4.80	4-5	
69	Tankage (Frentiss, Brooke & Co.).	6.14	5.77	3.40	7.04	3.07	10.11	10-11	7.04	-	2.27	1.6-2.7*	
77	New River Ammoniated Superphosphate.	13.81	1.2-2.05	3.40	6.20	2.83	12.43	8-12	9.60	10-12	2.22	2-3	
84	Bone and Potash (Bradley).	10.96	1.93-2.68	.90	4.74	6.83	12.56	8-12	5.73	8-9	1.93	2-2.5	
85	Rescue's May Flower Guano.	16.46	2.10-2.06	2.97	7.70	.86	11.53	9.5-12.5	10.67	-	-	-	
89	Blood, Meat and Bone.	6.00	5.77-7.41	.28	5.30	5.40	10.96	10-12	5.56	-	-	-	
83	Wilson's Dry Ground Fish Guano.	8.32	8-10	.77	4.21	3.12	8.10	-	4.98	4-6	-	-	
112	Blue Brand Excelsior Guano.	10.05	6.03	6.40	1.82	2.05	10.27	10-13	8.22	7-10	3.56	3*	
124	Rescue's May Flower.	9.25	2.00	3.08	6.95	.93	10.96	10-13	10.03	8.5-10	2.49	2-2.3	
224	Baker's Complete Grass Manure.	13.26	3.24	1.8-2.05	.41	.26	6.72	5	6.40	-	8.95	7.5	
238	Brightman's Fish Pomace.	39.09	4.87	7.19	1.64	2.85	3.68	9-13	9.20	8-11	7.14	7-8*	
48	Quintidine Market Garden Fertilizer.	12.83	3.44	3.30-4.12	1.04	1.37	10.76	7.36	2.81	-	6.88	5-6*	
46	Rescue's Dry Ground Fish.	7.38	8.72	8.65	4.1	2.40	4.55	6-8	8.11	5-6	3.4	2-3*	
66	Boyer's Law and Garden Dressing.	12.87	4.92	5.88	2.23	2.02	10.13	18-22	10.25	8-12	2.08	2-3*	
72	Dow's Ground Bone Fertilizer.	3.80	2.46	2.00-2.47	5.47	14.35	21.16	11.53	10.25	9-11	2.03	2-3*	
175	Standard Guano.	16.89	2.20	1-2	3.19	1.28	13.26	11-14	9.91	-	-	-	
186	B. D. Sea Fowl Guano.	15.75	2.5-3.25	6.63	3.23	2.35	13.26	11-14	9.91	-	-	-	
Bones.													
80	Crocker's Pure Ground Bone.	7.51	2.9-3.7	.23	4.94	17.35	22.52	26	6.17	-	23.17	19.01	
54	Quinnipiac Pure Bone Meal.	11.93	2.40	.10	6.08	15.38	31.56	20-25	6.18	-	62.67	35.82	
91	Pure Fine-ground Bone.	7.89	2.8	.60	8.91	10.80	29.21	20-42	9.41	13.62	62.59	16.67	
151	Standard Ground Bone.	11.80	2.5	3.04	5.94	5.26	14.24	14-16	8.98	5-7	36.18	10.25	
61	Lieber's Celebrated Ground Bone.	8.05	2.7-2.9	.32	4.06	6.83	12.15	12-14	8.27	-	58.15	17.15	
82	Dew's Ground Bone.	5.80	1.60-2.47	.10	8.21	18.06	26.43	24-36	8.37	-	64.17	50.83	

Sulphate of potash, the source of potash.

4. *Analyses of Commercial Fertilizers, etc. — Continued.*

Laboratory Number.	NAME OF BRAND	NAME OF MANUFACTURER.	Sampled at —
	<i>Compound Fertilizers.</i>		
13	Stockbridge's Manure for Top-dressing.	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
17	Hampton Lawn Dressing.	Bradley Fertilizer Company, Boston, Mass.,	Springfield.
32	Stockbridge's Manure for Top-dressing.	Bowker Fertilizer Company, Boston, Mass.,	Littleton.
34	Stockbridge's Manure for Strawberries and Small Fruit,	Bowker Fertilizer Company, Boston, Mass.,	Concord.
44	Engleish Lawn Dressing.	Bradley Fertilizer Company, Boston, Mass.,	Lowell.
47	Crocker's Special Potato Manure.	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Framingham.
49	Ammoniated Bone Superphosphate.	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	South Acton.
63	The H. L. Phelps' Complete Manure for Grass,	Frentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
71	Guanos and Potash.	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	North Adams.
81	Crocker's Special Potato Manure.	The Quinnipiac Company, Boston, Mass.,	Williamstown.
82	Quinnipiac Potato Manure.	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	North Adams.
83	Ammoniated Bone Superphosphate.	The Quinnipiac Company, Boston, Mass.,	Pittsfield.
87	Stockbridge's Manure for Seeding Down.	Leander Wilcox, Mystic, Conn.,	Williamstown.
94	Quinnipiac Grass Fertilizer.	Leander Wilcox, Mystic, Conn.,	Amherst.
100	Wilcox's High-grade Fish and Potash.	Bradley Fertilizer Company, Boston, Mass.,	Amherst.
101	Wilcox's Ammoniated Bone Phosphate.	Bradley Fertilizer Company, Boston, Mass.,	Sunderland.
105	Bradley's Complete Manure for Top-dressing.	Cleveland Dryer Company, Boston, Mass.,	Sunderland.
106	Bradley's Complete Manure for Potatoes and Vegetables.	E. Frank Coe, New York, N. Y.,	South Deerfield.
110	Cleveland Superphosphate.	John S. Reese & Co., Baltimore, Md.,	Barre Plains.
111	Red Brand Excelsior Guano.	John S. Reese & Co., Baltimore, Md.,	Barre Plains.
113	Bay State Fertilizer G. G.,	Joseph Church & Co., Tiverton, R. I.,	Dighton.
116	Concentrated Potato and Corn Manure.	Darling Fertilizer Company, Pawtucket, R. I.,	Worcester.
118	Church's Special Fertilizer.	Joseph Church & Co., Tiverton, R. I.,	Dighton.
120	Darling's Fertilizer for Gardens and Lawns.		
129	Church's Pure Dry Fish.		

## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.					POTASSIUM OXIDE IN ONE HUNDRED POUNDS.		
		Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	TOTAL.		Found.	Guaranteed.	
							Found.	Guaran- teed.			
Compound Fertilizers.											
12	Stockbridge's Manure for Top-dressing.	5.76	5-6	3.20	.83	6.33	10.36	6-7	4.03	3-4	5-6
32	Hamptden Lawn Dressing.	9.40	3.30-4.12	2.53	2.77	1.83	6.83	7-9	5.30	6-8	2-3
34	Stockbridge's Manure for Strawberries and Small Fruits.	10.47	2.50-3.25	7.01	1.28	2.51	10.80	7-9	8.29	6-7	4.32-5.40*
44	English Lawn Fertilizer.	8.94	4.96-5.78	2.99	2.88	1.09	6.96	6-8	5.87	5-7	2.50-3.50
47	Crocker's Special Potato Manure.	11.58	3.70-4.50	5.44	1.23	2.00	8.67	9-11	6.67	8-9	5-6*
49	Ammoniated Bone Superphosphate.	11.45	2.90-3.70	4.96	3.28	3.91	12.10	10-12	8.19	10-13	1-2*
63	The H. L. Phelps' Complete Manure for Grass, Guano and Potash.	11.62	4.12-4.94	4.91	1.73	.47	7.11	6-8	6.64	3-4	8-10
71	Quinnipiac Potato Manure.	11.66	3.30-4.12	1.07	3.84	2.97	7.38	6-6	4.41	-	5-7
82	Stockbridge's Manure for Seeding Down.	14.62	2.47-3.30	2.88	3.09	3.71	9.68	7-11	5.97	6-9	6-6*
87	Quinnipiac Grass Fertilizer.	11.95	3.36	6.37	5.27	2.30	12.94	12-14	10.54	6-8	5.05-6.32
96	Wilcox's High-grade Fish and Potash.	12.91	3.58	3.30-4.12	4.28	1.80	8.74	7-10	6.03	6-8	6-7*
100	Wilcox's Ammoniated Bone Phosphate.	22.50	3.28-4.25	2.65	1.89	2.05	6.59	6-7	4.54	6-6	4-5
101	Bradley's Ammoniated Bone Phosphate.	21.50	3.20-4.25	3.63	2.05	2.10	7.78	7-8	6.68	6-7	5-6
106	Bradley's Complete Manure for Potatoes and Vegetables.	8.21	6-7	1.92	2.78	2.02	6.72	6-9	4.70	5-7	2.50-3.50*
106	Cleveland Superphosphate.	11.26	3.73-4.52	4.30	5.06	2.56	11.92	9-13	9.26	8-11	6-7
110	Red Brand Excelsior Guano.	14.62	2.08-2.85	5.82	2.88	2.94	11.65	11-14	8.70	9-11	2-3*
111	Bay State Fertilizer G. G.	12.33	3.50-4	7.00	.18	3.28	10.46	10-14	7.19	9-12	6*
116	Concentrated Potato and Corn Manure.	19.31	1.90-2.60	2.61	8.16	.42	11.54	10-13	10.77	8-10	2.25-3
118	Church's Special Fertilizer.	15.61	2.97-3.80	3.83	4.63	.77	8.88	7-10	8.46	6-8	7.00-9.50
120	Darling's Fertilizer for Gardens and Lawns.	13.99	4.94-5.77	4.35	2.77	1.96	9.08	12-13	7.12	-	6-7
129	Church's Pure Dry Fish.	9.36	3.24-3.99	1.09	6.53	3.89	12.11	10-12	8.22	-	5-6
29		10.10		1.10	4.06	3.16	7.33	6.87-11.45	4.16	-	-

\* Sulphate of potash, the source of potash.

## 4. Analyses of Commercial Fertilizers, etc. — Continued.

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at—
<i>Compound Fertilizers.</i>			
29	Stockbridge's Manure for Corn, Grain and Fodder Corn,	Bowker Fertilizer Company, Boston, Mass.,	Littleton.
103	Gold Brand Excelsior Guano,	E. Frank Coe, New York, N. Y.,	Sunderland.
143	Bradley's Dry Ground Fish Guano,	Bradley Fertilizer Company, Boston, Mass.,	Taunton.
144	Bradley's Fish and Potash,	Bradley Fertilizer Company, Boston, Mass.,	New Bedford.
146	New England Favorite,	John S. Reese & Co., Baltimore, Md.,	New Bedford.
149	Columbus A. Manure,	John S. Reese & Co., Baltimore, Md.,	Lawrence.
153	Van Lawrence Fertilizer,	A. Lee & Co., Lawrence, Mass.,	Lowell.
163	Williams & Clark Company's Royal Bone Phosphate,	Williams & Clark Fertilizer Company, Boston, Mass.,	Lowell.
164	Williams & Clark Company's Prolific Crop Producer,	Williams & Clark Fertilizer Company, Boston, Mass.,	Boston.
171	Breck's Lawn and Garden Dressing,	Bowker Fertilizer Company, Boston, Mass.,	Woburn.
173	Mayo's Superphosphate,	Clarence E. Mayo & Co., Boston, Mass.,	Boston.
174	N. Ward Company's High-grade Animal Fertilizer,	The N. Ward Company, Boston, Mass.,	Greenfield.
182	Read's Standard Phosphate,	Read Fertilizer Company, Syracuse, N. Y.,	Northampton.
184	High-grade Farmers' Friend,	Read Fertilizer Company, Syracuse, N. Y.,	
<i>Chemicals.</i>			
21	Dissolved Bone-black,	Quinnipiac Fertilizer Company, Boston, Mass.,	Northampton.
23	Muriate of Potash,	Quinnipiac Fertilizer Company, Boston, Mass.,	Northampton.
55	High-grade Sulphate of Potash,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
57	Sulphate of Ammonia,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
58	Nitrate of Soda,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
65	Dissolved Bone-black,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
70	Muriate of Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
94	Sulphate of Potash,	Lucien Sanderson, New Haven, Conn.,	Hadley.
96	Muriate of Potash,	Lucien Sanderson, New Haven, Conn.,	Hadley.
<i>Wood Ashes.</i>			
14	Canada Wood Ashes,	Forest City Wood Ash Company, London, Ontario, Canada,	South Deerfield.
61	Canada Wood Ashes,	Wm. E. Fyfe & Co., Clinton, Mass.,	Concord.
180	Unleached Canada Wood Ashes,	Monroe, Jackson & Stroup, Oswego, N. Y.,	N. Amherst City.
189	Canada Hard-wood Ashes,	Thomas Joynt, St. Helen's, Ontario, Canada,	Northampton.

## 4. Analyses of Commercial Fertilizers, etc. — Concluded.

Laboratory Number.	NAME OF BRAND.	Mixture.	NITROGEN IN ONE HUNDRED POUNDS.		PHOSPHORIC ACID IN ONE HUNDRED POUNDS.						POTASSIUM OXIDE IN ONE HUNDRED POUNDS.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	TOTAL.		AVAILABLE.		Found.	Guaranteed.	
								Found.	Guaranteed.	Found.	Guaranteed.			
<i>Compound Fertilizers.</i>														
29	Stockbridge's Manure for Corn, Grain and Fodder	12.86	3.30	3.25-4.25	5.63	2.97	2.61	11.21	9-11	8.60	8-9	4.83	4.43-5.60	
103	Gold Brand Excelsior Guano.	10.62	2.86	2.5-3	5.88	3.56	2.25	13.80	-	11.44	8-11	5.03	6-8*	
143	Bradley's Dry Ground Fish Guano.	9.06	8.54	8.24-9.89	.88	3.42	4.80	8.80	6-8	4.00	6-8	2.35	2-3*	
144	Bradley's Fish and Potash.	19.51	8.20	2.43-3.60	3.79	2.91	1.82	8.52	7.5-9.5	8.70	9-12	2.62	2-3	
146	New England Favorite.	18.45	3.80	2.47-3.80	3.07	6.80	1.79	10.75	10-14	9.96	9-12	9.40	9.5-11	
149	Columbus A. Manure.	14.65	3.63	3.29-4.11	3.53	3.68	1.05	8.06	8-11	7.01	7-9	2.82	2-3	
153	The Lawrence Fertilizer.	12.96	2.71	2.06-2.88	6.12	4.37	1.84	12.83	10-12	10.49	7-9	2.13	2-3*	
163	Williams & Clark Co.'s Royal Bone Phosphate.	17.18	1.68	1.03-1.66	3.43	3.00	8.16	9.68	8-11	6.43	6-9	1.66	1-2*	
164	Williams & Clark Co.'s Prolific Crop Producer.	16.70	1.96	.82-1.65	4.95	3.83	2.10	10.38	7-11	8.28	6-9	4.96	5-6	
171	Breck's Lawn and Garden Dressing.	9.21	4.02	4.12-4.94	6.01	1.73	6.03	12.77	10-14	10.08	9-11	2.82	2.5-3.5	
173	Mayo's Superphosphate.	13.67	2.84	2.06-2.85	6.65	3.43	2.61	12.69	10-14	12.52	12-14	4.41	4-5	
174	N. Ward Co.'s High-grade Animal Fertilizer.	6.80	3.55	2.88-3.70	6.18	6.84	.70	13.22	10-12	9.89	8-10	3.08	4-6*	
182	Read's Standard Phosphate.	15.62	1.48	.82-1.65	7.01	1.73	1.15	9.89	10-12	8.74	8-10	9.46	10-11	
184	High-grade Farmers' Friend.	11.96	3.45	3.30-4.12	3.68	2.18	8.02	8.88	-	5.86	5-6	-	-	
<i>Chemicals.</i>														
21	Dissolved Bone-black.	18.82	-	-	12.84	1.81	.88	15.03	-	14.65	15-18	40.00	50.54-53.70	
23	Muriate of Potash.	1.13	-	-	-	-	-	-	-	-	-	48.32	51.88	
58	High-grade Sulphate of Potash.	1.55	-	-	-	-	-	-	-	-	-	-	-	
57	Sulphate of Ammonia.	2.63	19.98	19.77-20.57	-	-	-	-	-	-	-	-	-	
58	Sulphate of Soda.	1.81	15.76	15.65-16.14	-	-	-	-	-	-	-	-	-	
58	Dissolved Bone-black.	17.73	-	-	16.14	.27	.14	16.46	-	16.41	17.50	51.72	53.70	
70	Muriate of Potash.	1.85	-	-	-	-	-	-	-	-	-	26.52	27.02-29.72	
84	Sulphate of Potash.	3.77	-	-	-	-	-	-	-	-	-	50.64	50.54-53.70	
94	Muriate of Potash.	1.33	-	-	-	-	-	-	-	-	-	50.04	50.54-53.70	
<i>Wood Ashes.</i>														
14	Canada Wood Ashes.	11.15	-	-	-	-	-	1.65	1.5-2.5	-	-	5.37	4.5-8	
51	Canada Wood Ashes.	4.70	-	-	-	-	-	1.02	1-3	-	-	7.00	6-8	
180	Unbleached Canada Wood Ashes.	24.69	-	-	-	-	-	1.56	1-2.5	-	-	4.48	4.5-7	
180	Canada Hard-wood Ashes.	16.52	-	-	-	-	-	1.57	-	-	-	4.64	5-7	

\* Sulphate of potash, the source of potash.

*Methods of Fertilizer Analysis.*

*Preparation of Sample.*—The entire available sample is spread upon a smooth, hard surface, and intimately mixed without grinding, all lumps being broken up with a spatula. Unnecessary loss or gain of moisture is to be avoided. *Moisture:* dry 2 grams in the air-bath at 100 to 110° C. to constant weight.

1. *Total Phosphoric Acid.*—Weigh out 2 grams in a platinum crucible, and destroy the organic matter by carefully burning in a muffle. Weigh when cool, to determine the “organic and volatile matter.” Digest the crucible and contents with dilute hydrochloric acid, until the solution of the latter is complete. Filter, and evaporate the filtrate to complete dryness. The “insoluble matter” on the filter is burned and weighed. The residue left from the evaporation is taken up with dilute nitric acid, if the molybdic method is to be followed, but with hydrochloric acid if method (2) is preferred. The solution after filtering is made up to a volume of 200 cubic centimetres with distilled water.

(1) The molybdic method: 25 cubic centimetres of the solution are digested in a water-bath at 65° C. from one to two hours, with an excess of molybdic solution. The precipitate is brought upon a filter, and washed with water containing a little molybdic solution. It is then dissolved in ammonia water, the solution nearly neutralized with hydrochloric acid, and magnesia mixture added slowly, with constant stirring. The precipitate is allowed to stand at least three hours, when it is filtered through a Gooch crucible, washed with dilute ammonia, ignited and weighed.

(2) The following method is occasionally employed when phosphates of iron and alumina are present in small quantities only: To 50 cubic centimetres of the hydrochloric acid solution add ammonia in slight excess. After standing a few minutes, acidify with acetic acid, and filter off the phosphates of iron and alumina, washing carefully with water. To the filtrate add sufficient oxalate of ammonia to precipitate all the lime; digest for several hours at a temperature below boiling, and filter through double filters which have previously been washed with oxalate of ammonia, washing



thoroughly with water. Dissolve the phosphates of iron and alumina on the filter with warm dilute hydrochloric acid, and wash into a beaker containing a small quantity of powdered tartaric acid. When the latter has gone into solution, mix with the filtrate from the oxalate of ammonia. The phosphoric acid is precipitated with magnesia mixture, and treated as in (1).

**Soluble phosphoric acid:** Weigh out 2 grams into a beaker, cover with 10 to 15 cubic centimetres of water, and allow it to stand for fifteen minutes, stirring three times at equal intervals. Decant the solution through a filter into a graduated cylinder. Add another like quantity of water, and let it stand fifteen minutes more, stirring as before. Filter the solution into the cylinder, and wash the residue on the filter until the filtrate amounts to 200 cubic centimetres. The phosphoric acid is determined in an aliquot part of the solution as under total phosphoric acid.

**Insoluble phosphoric acid:** Add 100 cubic centimeters of neutral ammonia citrate (sp. gr. 1.09) to the beaker in which the digestion with water has been made. Put in a water-bath and heat to 65° C. Drop in the filter containing the residue from the above operation, and digest for thirty minutes, stirring every five minutes. Filter and wash thoroughly, using the suction pump. Dry, and burn. The ash is then treated as under total phosphoric acid.

**Reverted phosphoric acid:** The sum of the soluble and insoluble subtracted from the total gives the reverted or citrate-soluble phosphoric acid.

**Reagents:** The reagents used in the estimation of phosphoric acid are prepared according to directions given in the "Proceedings of the Association of Official Agricultural Chemists," 1890 (pages 228 and 229).

For ammonium citrate, 370 grams of citric acid are dissolved in 1,500 cubic centimetres of water, nearly neutralized with crushed carbonate of ammonia, heated to expel carbonic acid, exactly neutralized with ammonia, and brought to a specific gravity of 1.09.

The molybdic solution is prepared by dissolving 100 grams of molybdic acid in 417 cubic centimetres of ammonia of specific gravity .96. Pour this solution into 1,250 cubic

centimetres of nitric acid of specific gravity 1.20, and set in a warm place for several days, or until a portion heated to 40° C. deposits no yellow precipitate.

The magnesia mixture is prepared by dissolving 110 grams of crystallized magnesium chloride and 280 grams of ammonium chloride in 700 cubic centimetres of ammonia of specific gravity .96, and bringing to a volume of two liters.

2. *Methods of Determining Nitrogen.*—The Kjeldahl and soda-lime methods recommended by the Association of Official Agricultural Chemists, in their “Proceedings,” 1890, pages 190 and 191, are employed, with occasional control analyses by the absolute cupric oxide mode.

3. *Method for Determining Potash.*—Weigh out two grams of the material in a platinum crucible, and char thoroughly at a temperature just below red heat. Digest for several hours with very dilute hydrochloric acid, on the water-bath. Filter into a graduated cylinder, and make up to 200 cubic centimetres. Take 50 cubic centimetres for each test. Warm, and add in small quantities at a time, an excess of barium hydrate. Digest for one or two hours at a temperature of 70° to 90° C., filter, washing carefully, and add to the filtrate a few drops of ammonium hydrate, and enough ammonium carbonate to precipitate the excess of barium hydrate. Filter, and bring the filtrate to dryness on the water-bath in a platinum dish. Heat carefully in the covered platinum dish at a temperature just below red heat, until compounds of ammonia cease to come off. Take up the residue in water, filtering if necessary, and add an excess of platinum tetrachloride. Evaporate to dryness on the water-bath, add a small quantity of 80 per cent. alcohol, and allow it to stand for a few hours. Filter through a Gooch crucible, washing with alcohol, dry, and weigh; or filter through paper, wash as before, dry, and brush the potassium platonic chloride upon a weighed watch glass, with a camel's-hair brush, and weigh. If very impure, the double salt is washed with the strong solution of ammonium chloride, saturated with potassium platonic chloride, as recommended in the “Proceedings of the Association of Official Agricultural Chemists,” 1890, page 210.

5. *Analyses of Commercial Fertilizers and Manurial Substances sent on for Examination.*

*Wood Ashes.*

[I., Canada wood ashes, sent on from Stow, Mass ; II., Home-made ashes, sent on from Stow, Mass.; III. and IV., sent on from North Amherst, Mass.; V., sent on from North Hatfield, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . . . . .	14.88	0.25	29.49	30.69	8.68
Calcium oxide, . . . . .	33.42	37.16	28.79	24.75	33.19
Magnesium oxide, . . . . .	2.89	6.31	3.74	2.04	4.21
Ferric oxide, . . . . .	1.03	2.26	0.84	0.97	1.03
Potassium oxide, . . . . .	6.17	6.58	2.32	2.78	6.58
Phosphoric acid, . . . . .	2.19	5.58	1.58	1.84	2.01
Insoluble matter (before calcination),	13.67	27.45	11.72	16.66	14.66
Insoluble matter (after calcination),	11.07	22.93	10.37	13.08	12.21

*Wood Ashes.*

[I., sent on from Lawrence, Mass ; II., sent on from Hadley, Mass ; III., sent on from Hudson, Mass.; IV., sent on from Clifton, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C., . . . . .	8.71	13.18	18.00	15.94
Calcium oxide, . . . . .	36.95	34.06	33.25	31.65
Magnesium oxide, . . . . .	2.90	2.88	1.84	2.59
Ferric oxide, . . . . .	0.07	1.32	1.42	1.62
Potassium oxide, . . . . .	5.77	4.56	4.51	4.71
Phosphoric acid, . . . . .	1.38	1.66	1.18	1.43
Insoluble matter (before calcination),	13.15	13.60	12.99	13.38
Insoluble matter (after calcination), .	11.88	11.16	10.84	10.62

5. *Analyses, etc.*—Continued.*Wood Ashes.*

[I., from North Amherst, Mass.; II., from North Hadley, Mass.; III., Railroad tie ashes, from Winchester, Mass.; IV., from Hudson, Mass.; V., from North Amherst, Mass.; VI., from Lawrence, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., . . .	11.47	3.46	4.70	18.10	10.38	16.12
Calcium oxide, . . .	37.51	35.76	2.51	31.75	23.84	30.38
Magnesium oxide, . . .	3.20	4.32	1.22	2.59	3.05	2.64
Ferric oxide, . . .	0.24	0.55	4.23	0.77	5.89	1.32
Potassium oxide, . . .	4.22	4.21	0.92	3.32	2.93	3.94
Phosphoric acid, . . .	1.40	2.01	0.56	1.34	1.14	1.52
Insoluble matter (before calcination), . . .	18.84	17.19	84.51	12.53	35.27	17.52
Insoluble matter (after calcination), . . .	16.11	14.85	80.20	10.53	33.73	13.10

*Wood Ashes.*

[I., sent on from East Whately, Mass.; II., III., IV. and V., sent on from Concord, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . . .	10.52	3.60	21.40	13.75	15.14
Calcium oxide, . . .	37.07	33.78	29.65	33.39	—
Magnesium oxide, . . .	3.46	6.66	4.16	3.38	—
Ferric oxide, . . .	0.72	1.51	0.78	0.49	—
Potassium oxide, . . .	6.48	9.62	5.22	7.24	5.75
Phosphoric acid, . . .	1.43	4.25	1.54	1.53	1.69
Insoluble matter (before calcination), . . .	9.70	9.98	9.87	10.96	13.44
Insoluble matter (after calcination), . . .	7.06	5.52	7.96	9.19	11.40

All above-stated samples of unleached wood ashes are represented as Canada wood ashes, except No. II., which is a home-made wood ash.

5. *Analyses, etc. — Continued.**Wood Ashes.*

[I., sent on from Concord, Mass.; II., sent on from Beverly, Mass.; III., sent on from Sunderland, Mass.; IV., sent on from North Amherst, Mass.; V., sent on from Sunderland, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . . . .	15.50	11.78	15.69	9.52	17.48
Calcium oxide, . . . .	30.16	29.12	31.59	25.12	32.23
Magnesium oxide, . . . .	3.28	4.53	3.90	4.67	3.07
Ferric oxide, . . . .	0.99	1.14	0.40	1.49	0.67
Potassium oxide, . . . .	6.76	4.77	6.99	3.83	5.04
Phosphoric acid, . . . .	2.13	1.83	1.39	1.40	1.17
Insoluble matter (before calcination),	12.04	15.16	11.10	28.38	11.72
Insoluble matter (after calcination),	11.68	11.48	10.26	22.05	10.74

*Wood Ashes.*

[I., sent on from Rock Bottom, Mass.; II., sent on from South Framingham, Mass.; III., sent on from Berlin, Mass.; IV., sent on from Amesbury, Mass.; V., sent on from Beverly, Mass.; VI., sent on from Bolton, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., . . . .	18.00	20.08	2.10	9.43	10.22	11.50
Calcium oxide, . . . .	34.40	32.16	36.00	32.52	38.98	35.66
Magnesium oxide, . . . .	2.90	3.28	3.30	2.14	3.39	4.45
Ferric oxide, . . . .	—	0.69	—	—	—	—
Potassium oxide, . . . .	4.52	4.65	5.27	4.90	6.28	4.57
Phosphoric acid, . . . .	1.46	2.70	1.62	1.84	1.42	1.56
Insoluble matter (before calcination), . . . .	12.39	9.67	19.47	20.52	9.51	16.58
Insoluble matter (after calcination), . . . .	11.44	8.12	17.78	18.30	8.54	14.83

All above-stated samples of unleached wood ashes are represented as Canada wood ashes. Samples I., II., IV. and VI. contain less potash than the average of Canada wood ash usually sold in our markets.

5. *Analyses, etc.—Continued.**Wood Ashes.*

[I., sent on from Framingham, Mass.; II. and III., sent on from South Deerfield, Mass.; IV., sent on from Essex, Mass.; V. and VI., sent on from Sudbury, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., . . .	19.73	7.26	20.65	0.64	16.64	24.26
Calcium oxide, . . .	31.49	37.07	29.65	40.49	—	—
Magnesium oxide, . . .	2.85	2.90	2.70	3.07	—	—
Ferric oxide, . . .	1.24	1.02	1.89	—	—	—
Potassium oxide, . . .	4.94	4.34	4.62	6.42	4.24	4.71
Phosphoric acid, . . .	1.57	1.48	1.46	1.57	1.34	2.66
Insoluble matter (before calcination), . . .	12.57	14.45	10.10	12.03	18.08	23.92
Insoluble matter (after calcination), . . .	10.29	12.48	8.13	9.10	14.84	19.92

*Wood Ashes.*

[I., sent on from Amherst, Mass.; II., sent on from Holden, Mass.; III. and IV., sent on from Concord, Mass.; V., sent on from Rock Bottom, Mass.; VI., sent on from Stow, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., . . .	12.34	19.34	17.98	16.65	11.62	13.27
Calcium oxide, . . .	33.08	30.27	28.86	30.36	35.63	34.74
Magnesium oxide, . . .	2.85	3.98	3.12	3.10	2.97	3.04
Ferric oxide, . . .	0.79	0.86	0.09	1.44	0.86	0.66
Potassium oxide, . . .	5.60	5.11	6.81	6.10	6.40	6.32
Phosphoric acid, . . .	1.93	3.53	1.66	1.54	1.60	1.57
Insoluble matter (before calcination), . . .	15.45	10.86	17.22	13.00	10.93	10.02
Insoluble matter (after calcination), . . .	11.19	9.37	14.66	11.32	9.02	8.44

5. *Analyses, etc.* — Continued.*Cotton-seed-hull Ashes.*

[I., sent on from Sunderland, Mass.; II. and III., sent on from North Hadley, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	7.77	6.30	4.58
Calcium oxide, . . . . .	8.02	—	—
Magnesium oxide, . . . . .	12.57	—	—
Potassium oxide, . . . . .	30.00	16.48	9.91
Phosphoric acid, . . . . .	13.19	6.58	4.41
Insoluble matter (before calcination), . . . . .	12.52	41.94	57.40
Insoluble matter (after calcination), . . . . .	9.40	29.65	34.28

Sample II. and in particular Sample III. are of an exceptional inferior quality. Cotton-seed-hull ashes and cotton-seed meal sold for manurial purposes ought to be bought on a guaranteed composition. Both articles are liable to a serious fluctuation in composition. All articles sold for manurial purposes, at ten dollars or more per ton, are subject to our laws for the regulation of the trade in commercial fertilizers.

*Cotton-hull Ashes.*

[I., sent on from North Hadley, Mass.; II., sent on from Feeding Hills, Mass.; III., sent on from Sunderland, Mass.\*]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	11.79	6.30	4.41
Calcium oxide, . . . . .	8.37	13.94	4.91
Magnesium oxide, . . . . .	10.27	2.85	5.57
Ferric and aluminic oxides, . . . . .	1.50	2.49	4.35
Potassium oxide, . . . . .	26.26	26.98	16.63
Phosphoric acid, . . . . .	12.06	8.40	7.21
Insoluble matter (before calcination), . . . . .	15.37	13.23	47.47
Insoluble matter (after calcination), . . . . .	11.94	11.19	40.02

\* Cotton-hull and wood ashes mixed.

5. *Analyses, etc. — Continued.**Cotton-hull Ashes.*

[Three samples, sent on from Hatfield, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C, . . . . .	14.18	13.65	14.22
Calcium oxide, . . . . .	10.26	15.12	15.25
Magnesium oxide, . . . . .	10.28	6.37	6.02
Ferric oxide, . . . . .	1.88	1.51	1.08
Potassium oxide, . . . . .	20.56	27.06	26.91
Phosphoric acid, . . . . .	9.13	8.07	13.48
Insoluble matter (before calcination), . .	12.64	10.14	9.87
Insoluble matter (after calcination), . .	11.48	8.10	7.24

*Cotton-seed Meal for Fertilizer.*

[I. and II., sent on from Hatfield, Mass.; III., sent on from Amherst, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	7.98	9.84	7.28
Ash, . . . . .	-	-	7.14
Phosphoric acid, . . . . .	3.26	3.30	2.20
Potassium oxide, . . . . .	2.01	2.03	2.06
Nitrogen, . . . . .	6.21	6.64	6.28
Insoluble matter, . . . . .	0.07	0.08	0.09



5. *Analyses, etc.* — Continued.*Calcium Sulphate.*

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	18.02
Calcium oxide, . . . . .	32.40
Sulphuric acid, . . . . .	42.08
Insoluble matter, . . . . .	2.35

*Burnt Lime.*

[Sent on from Amherst, Mass.]

	Per Cent.
Calcium oxide, . . . . .	88.64
Insoluble matter, . . . . .	4.71

*Nitrate of Soda.*[I., sent on from South Sudbury, Mass.; II., sent on from North Hadley, Mass.;  
III., sent on from Amherst, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	1.38	1.78	1.20
Sodium oxide, . . . . .	—	—	38.90
Nitrogen, . . . . .	15.56	15.77	15.81

*Muriate of Potash.*[I., sent on from Hadley, Mass.; II., sent on from Richmond, Mass.; III., sent  
on from Amherst, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	1.40	1.30	1.09
Potassium oxide, . . . . .	49.95	46.64	50.40
Insoluble matter, . . . . .	—	0.44	—

5. *Analyses, etc.* — Continued.*Sulphate of Potash.*

[Sent on from Richmond, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	6.17
Potassium oxide, . . . . .	24.32
Insoluble matter, . . . . .	0.56

*Florida Phosphate Rock.*

[I., sent on from Amherst; II., sent on from Fort Meade, Fla.; III. and IV., sent on from Vicksburg, Miss.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C., . . . . .	2.24	13.62	1.59	1.38
Phosphoric acid, . . . . .	21.67	22.42	23.96	23.71
Calcium oxide, . . . . .	—	28.06	35.41	33.84
Ferric and aluminic oxides, . . . . .	5.02	9.46	9.70	4.80
Insoluble matter, . . . . .	34.67	23.30	4.68	9.52
Carbonic acid, . . . . .	Trace.	—	—	—

*Florida Phosphate Rock.*

[I., II., III. and IV., from Ocala, Fla.; V., from Pitman, Fla.; VI., sent on from Boston, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., . . . . .	2.03	1.90	6.53	0.99	5.28	0.58
Phosphoric acid, . . . . .	21.34	24.10	7.68	38.97	18.23	32.18
Calcium oxide, . . . . .	—	—	—	—	—	29.78
Ferric and aluminic oxides, . . . . .	2.53	2.42	2.84	1.20	3.11	15.85
Insoluble matter, . . . . .	24.64	26.44	48.77	2.35	33.89	9.16

5. *Analyses, etc.* — Continued.*Dissolved Bone-black.*

[I. and II., sent on from Amherst, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	18.50	15.15
Ash, . . . . .	55.52	50.40
Total phosphoric acid, . . . . .	15.35	17.55
Soluble phosphoric acid, . . . . .	14.87	17.51
Reverted phosphoric acid, . . . . .	0.29	—
Insoluble phosphoric acid, . . . . .	0.19	—
Insoluble matter, . . . . .	2.95	0.12

*Superphosphate.*

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	14.23
Ash, . . . . .	69.95
Total phosphoric acid, . . . . .	14.64
Soluble phosphoric acid, . . . . .	10.34
Reverted phosphoric acid, . . . . .	2.42
Insoluble phosphoric acid, . . . . .	1.88
Insoluble matter, . . . . .	10.81

*Fine-ground Bone.*

[Sent on from Amherst, Mass.]

*Mechanical Analysis.*

	Per Cent.
Fine, . . . . .	48.57
Fine medium, . . . . .	24.20
Medium, . . . . .	20.59
Coarse medium, . . . . .	6.64

*Chemical Analysis.*

Moisture at 100° C., . . . . .	8.40
Ash, . . . . .	54.81
Total phosphoric acid, . . . . .	15.16
Soluble phosphoric acid, . . . . .	2.33
Reverted phosphoric acid, . . . . .	6.42
Insoluble phosphoric acid, . . . . .	6.41
Nitrogen, . . . . .	3.89
Insoluble matter, . . . . .	0.42

5. *Analyses, etc.* — Continued.*Tankage.*

[I., sent on from Worcester, Mass.; II., sent on from Hadley, Mass.; III., sent on from Lexington, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	5.78	6.05	40.92
Ash, . . . . .	49.57	35.58	28.53
Total phosphoric acid, . . . . .	18.86	8.65	7.39
Soluble phosphoric acid, . . . . .	0.54	0.05	Trace.
Reverted phosphoric acid, . . . . .	9.88	5.39	4.30
Insoluble phosphoric acid, . . . . .	8.38	3.21	3.09
Nitrogen, . . . . .	4.16	5.04	4.73
Insoluble matter, . . . . .	1.48	2.62	0.40

*Dry Ground Fish.*

[I., sent on from Hadley, Mass.; II., sent on from North Hadley, Mass.; III., sent on from Amherst, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C., . . . . .	10.54	9.12	13.66
Ash, . . . . .	17.45	20.13	19.23
Total phosphoric acid, . . . . .	6.75	7.04	7.39
Soluble phosphoric acid, . . . . .	0.75	0.27	—
Reverted phosphoric acid, . . . . .	3.25	3.10	—
Insoluble phosphoric acid, . . . . .	2.75	3.67	—
Nitrogen, . . . . .	7.64	8.47	9.16
Insoluble matter, . . . . .	1.06	2.85	2.39

5. *Analyses, etc.* — Continued.*Fish Chum.*

[Sent on from Beverly, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	6.46
Ash, . . . . .	25.33
Total phosphoric acid, . . . . .	9.15
Soluble phosphoric acid, . . . . .	0.56
Reverted phosphoric acid, . . . . .	5.99
Insoluble phosphoric acid, . . . . .	2.60
Nitrogen, . . . . .	5.50
Insoluble matter, . . . . .	1.12

*Wool Waste from Factories.*

[I., shoddy mill waste, sent on from Lawrence, Mass.; II., wool waste, sent on from Spencer, Mass.; III., wool refuse, sent on from Gilbertville, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C, . . . . .	11.38	43.05	27.05
Ash, . . . . .	12.23	3.93	38.84
Potassium oxide, . . . . .	0.14	0.06	0.42
Phosphoric acid, . . . . .	0.08	0.05	0.07
Nitrogen, . . . . .	3.44	6.67	1.05
Insoluble matter, . . . . .	7.52	1.08	34.00

The best use which can be made of this class of refuse materials is to incorporate them into the barn-yard manure; they are essentially a nitrogenous source of plant food. Their commercial manurial value depends on their percentage of nitrogen. From seven to eight cents per pound of the latter is a fair basis of valuation.

*Cotton Waste.*

[Sent on from Fall River, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	5.63
Ash, . . . . .	60.68
Potassium oxide, . . . . .	0.66
Phosphoric acid, . . . . .	0.26
Nitrogen, . . . . .	0.96
Insoluble matter, . . . . .	55.20

5. *Analyses, etc.* — Continued.*Tobacco Leaves.*

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	11.97
Ash, . . . . .	20.48
Calcium oxide, . . . . .	4.83
Magnesium oxide, . . . . .	1.86
Ferric oxide, . . . . .	0.22
Potassium oxide, . . . . .	6.06
Phosphoric acid, . . . . .	1.15
Nitrogen, . . . . .	2.95
Insoluble matter, . . . . .	2.35

The tobacco leaves contain more than twice the amount of mineral constituents found in the tobacco stems. The ash of the latter contains more phosphoric acid and potash than that of the former, while that of the leaves is richer in lime and magnesia than that of the stems.

*Saltpetre Waste.*

[Sent on from Littleton Common, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	1.23
Potassium oxide, . . . . .	2.70
Sodium oxide, . . . . .	47.99
Nitrogen, . . . . .	0.61

The material contains usually a large amount of common salt, and may be used with good effect upon grass lands.

*Waste from Lactate Factory.*

[Sent on from Littleton Centre, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	34.11
Ash, . . . . .	60.24
Calcium oxide, . . . . .	22.55
Potassium oxide, . . . . .	Trace.
Phosphoric acid, . . . . .	0.67
Nitrogen, . . . . .	0.68
Insoluble matter, . . . . .	6.92

5. *Analyses, etc.* — Continued.*Muck.*

[I., sent on from Brookline, Mass.; II., sent on from Fort Meade, Fla.; III. and IV., sent on from Boston, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C., . . . .	81.03	31.17	70.00	74.87
Organic matter, . . . .	10.96	4.18	14.84	14.46
Ash, . . . .	8.01	64.65	15.16	10.67
Calcium oxide, . . . .	—	—	0.28	0.14
Nitrogen, . . . .	0.36	0.06	0.49	0.46
Phosphoric acid, . . . .	—	—	0.17	0.073
Insoluble matter, . . . .	7.04	59.13	13.47	9.24

*Peat.*

[Sent on from Marshfield, Mass.]

	Per Cent.
Moisture at 100° C, . . . .	35.17
Ash, . . . .	21.92
Nitrogen, . . . .	1.16

*Mud.*

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C., . . . .	22.45
Organic matter, . . . .	10.83
Ash, . . . .	66.72
Calcium oxide, . . . .	3.64
Potassium oxide, . . . .	0.25
Phosphoric acid, . . . .	Trace.
Nitrogen, . . . .	0.43
Insoluble matter, . . . .	29.26

5. *Analyses, etc.* — Continued.*Marl.*

[I., sent on from West Springfield, Mass.; II., sent on from Marshfield, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	1.65	3.15
Calcium oxide, . . . . .	47.61	0.37
Magnesium oxide, . . . . .	0.58	1.71
Ferric oxide, . . . . .	Trace.	Trace.
Potassium oxide, . . . . .	Trace.	0.24
Phosphoric acid, . . . . .	0.10	1.41
Carbonic acid, . . . . .	34.03	None.
Insoluble matter, . . . . .	2.81	79.73 .

*Home-mixed Fertilizers.*

[I., sent on from North Hadley, Mass.; II., sent on from Agawam, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	15.86	9.69
Ash, . . . . .	63.56	39.20
Total phosphoric acid, . . . . .	12.88	5.36
Soluble phosphoric acid, . . . . .	8.24	1.69
Reverted phosphoric acid, . . . . .	2.87	3.06
Insoluble phosphoric acid, . . . . .	1.77	0.61
Potassium oxide, . . . . .	5.97	8.28
Nitrogen, . . . . .	1.53	4.30
Insoluble matter, . . . . .	1.69	0.87



5. *Analyses, etc.* — Concluded.*Complete Fertilizers.*

[I., sent on from Boston, Mass.; II., home-mixed fertilizer, sent on from Conway, Mass.; III. and IV., sent on from North Hadley, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C., . . .	6.54	6.67	17.78	14.54
Ash, . . . . .	46.27	49.21	50.12	48.42
Total phosphoric acid, . . .	11.64	13.82	4.57	7.42
Soluble phosphoric acid, . . .	7.78	6.27	1.77	6.90
Reverted phosphoric acid, . . .	2.81	5.99	0.78	0.33
Insoluble phosphoric acid, . . .	1.05	1.56	2.02	0.19
Potassium oxide, . . . . .	4.29	4.98	10.72	7.19
Nitrogen, . . . . .	3.66	3.44	5.14	3.75
Insoluble matter, . . . . .	1.72	0.64	3.12	0.81

*Complete Fertilizers.*

[I., II. and III., sent on from South Sudbury, Mass.; IV., sent on from Sixteen Acres, Mass.; V. and VI., sent on from Richmond, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., . . .	18.05	15.92	16.54	12.43	12.14	13.54
Ash, . . . . .	56.55	55.82	69.10	37.44	48.40	46.96
Total phosphoric acid, . . .	8.47	11.68	10.26	8.05	9.44	10.87
Soluble phosphoric acid, . . .	1.64	6.91	7.16	2.58	3.48	6.12
Reverted phosphoric acid, . . .	3.67	1.19	1.69	3.27	3.24	3.59
Insoluble phosphoric acid, . . .	3.16	3.58	1.36	2.20	2.72	1.16
Potassium oxide, . . . . .	4.04	2.32	1.98	6.08	7.94	5.20
Nitrogen, . . . . .	2.13	2.28	1.10	2.58	2.89	2.73
Insoluble matter, . . . . .	3.58	5.37	6.72	1.10	1.82	0.64

6. *Miscellaneous Analyses.**Paris Green.*

[I. and II., sent on by the Gypsy Moth Commission from Boston, Mass.; III. and IV., sent on from Amherst, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C., . . . .	1.30	1.15	1.41	1.40
Copper oxide, . . . .	32.84	30.40	33.20	33.10
Arsenious oxide, . . . .	62.55	59.92	61.40	61.15
Insoluble matter, . . . .	0.21	0.10	0.09	0.64
Acetic acid, . . . .	3.10	8.43	3.90	3.71

*Tobacco Liquor.*

[Two samples sent on from Hyannis, Mass.]

	PER CENT.	
	I.	II.
Nicotine, . . . . .	4.55	4.82

*Dalmation Insect Powder.*

[Sent on from Boston, Mass.]

	Per Cent.
Total ash, . . . . .	15.52
Ash insoluble in hydrochloric acid, . . . . .	9.20

No trace of mineral poisons was found. Under the microscope the vegetable matter had the general appearance of genuine pyrethrum powder.

6. *Miscellaneous Analyses* — Continued.*Carnation Pinks (Whole Plant).*

[Sent on from Framingham, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	8.08
Ash, . . . . .	8.80
Calcium oxide, . . . . .	1.64
Magnesium oxide, . . . . .	0.35
Ferric and aluminic oxides, . . . . .	0.03
Sodium oxide, . . . . .	1.13
Potassium oxide, . . . . .	3.35
Phosphoric acid, . . . . .	0.46
Nitrogen, . . . . .	1.06
Insoluble matter, . . . . .	0.21

*Grapes.*

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	86.23
Ash, . . . . .	0.5481
100 parts of ash contain : —	
Calcium oxide, . . . . .	3.50
Magnesium oxide, . . . . .	2.531
Ferric oxide, . . . . .	1.193
Potassium oxide, . . . . .	49.765
Phosphoric acid, . . . . .	13.567
Nitrogen (in dry matter), . . . . .	0.961

*Woods.\**

[I., sound wood of plum; II., black knot of plum.]

	PER CENT.	
	I.	II.
Moisture at 100° C., . . . . .	6.590	7.990
Ash, . . . . .	2.220	4.220
Calcium oxide, . . . . .	0.684	0.690
Magnesium oxide, . . . . .	0.119	0.232
Ferric oxide, . . . . .	0.012	0.052
Potassium oxide, . . . . .	0.987	1.438
Phosphoric acid, . . . . .	0.132	0.475
Nitrogen, . . . . .	0.570	1.450
Insoluble matter, . . . . .	0.013	0.009

\* Collected off of the same tree, Amherst, Mass.

6. *Miscellaneous Analyses* — Continued.*Banana Skins.*

[Sent on from Boston, Mass.]

	Per Cent.
Moisture at 100° C., . . . . .	13.99
Ash, . . . . .	13.06
Calcium oxide, . . . . .	1.44
Magnesium oxide, . . . . .	0.11
Ferric and aluminic oxides, . . . . .	0.26
Potassium oxide, . . . . .	5.46
Phosphoric acid, . . . . .	1.48
Nitrogen, . . . . .	0.24

*Analysis of the Ash.*

Calcium oxide, . . . . .	11.12
Magnesium oxide, . . . . .	0.84
Ferric and aluminic oxides, . . . . .	1.99
Potassium oxide, . . . . .	41.80
Phosphoric acid, . . . . .	11.33
Insoluble matter, . . . . .	10.15

*Sugar Beets.*

[Sent on from Boston, Mass.]

*Analysis of Beets.*

	Per Cent.
Moisture at 100° C., . . . . .	77.35
Sugar by Fehling's test, . . . . .	13.57
Sugar by polariscope, . . . . .	13.59

*Analysis of Juice.*

Degrees Brix, corresponding for temperature, . . . . .	21.2°
Specific gravity, . . . . .	1.08869
Total solids, . . . . .	20.52
Ash, . . . . .	1.65
Sugar by Fehling's test, . . . . .	16.02
Coefficient of purity, . . . . .	78.05

*Vinegar.*

[I., sent on from Williamsburg, Mass.; II., III., IV., V., sent on from Prescott, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Specific gravity, . . . . .	1.02565	1.00998	1.00732	1.01172	1.00448
Acetic acid, . . . . .	4.80	4.66	4.82	5.27	3.97
Solid residue, . . . . .	4.51	1.70	1.76	1.55	1.00

6. *Miscellaneous Analyses* — Continued.*Vinegar.*

[Sent on from Amherst, Mass.]

	PER CENT.	
	I.	II.
Specific gravity, . . . . .	1.01086	1.01206
Acetic acid, . . . . .	5.02	5.15
Solid residue, . . . . .	1.51	1.48

*Vinegar Mash.*

[Sent on from Boston, Mass. I., total solid residue on evaporation; II., residue from which liquid or soluble portion had been removed (insoluble residue).]

*Average Composition.*

	PER CENT.
Moisture at 100° C., . . . . .	94.49
Dry matter, . . . . .	5.51

100.00

*Analysis of Dry Matter.*

	PER CENT.	
	I.	II.
Crude ash, . . . . .	3.03	2.92
“ cellulose, . . . . .	8.55	9.42
“ fat, . . . . .	8.45	7.77
“ protein, . . . . .	16.50	13.91
Non-nitrogenous extract matter, . . . .	63.47	65.98
	100.00	100.00
Nitrogen in dry matter, . . . . .	2.64	2.22
Potassium oxide in dry matter, . . . .	0.84	0.34
Phosphoric acid in dry matter, . . . .	1.27	0.93
Acidity (calculated as acetic acid), . .	—	0.33

6. *Miscellaneous Analyses*—Continued.*Baking Powder.*

[Sent on from Amherst, Mass.]

	Per Cent.
Total carbonic acid, . . . . .	8.28
Phosphoric acid, . . . . .	0.10
Sulphuric acid, . . . . .	11.17
Aluminic oxide, . . . . .	2.00

*Analyses of Milk sent on for Examination.*

[Per Cent.]

Number of Sample.	Solids.	Fat.	Solids not Fat.	Locality.	Remarks.
1, . .	11.95	3.18	8.77	Lee.	Skim-milk.
2, . .	11.96	3.51	8.45		
3, . .	9.42	0.63	8.79		
4, . .	13.21	3.90	9.31	Millbury.	Buttermilk.
5, . .	12.74	4.20	8.54	Lee.	
6, . .	9.24	0.28	8.96	Belchertown.	
7, . .	11.18	2.92	8.26	Lawrence.	Skim-milk.
8, . .	9.31	0.20	9.11	Tully.	
9, . .	12.72	4.23	8.49	Amherst.	
10, . .	11.94	3.16	8.78		
11, . .	13.28	4.17	9.11		
12, . .	14.19	5.10	9.09	Warren.	
13, . .	12.84	3.85	8.99		
14, . .	14.10	4.54	9.56		
15, . .	13.28	3.79	9.49	Worcester.	
16, . .	13.18	3.87	9.31		
17, . .	13.98	4.73	9.25		
18, . .	15.76	5.95	9.81	Warren.	
19, . .	14.47	4.30	10.17		
20, . .	15.93	6.40	9.53		
21, . .	16.68	6.75	9.93	Warren.	
22, . .	16.64	6.92	9.72		
23, . .	15.39	5.85	9.54		
24, . .	13.64	4.43	9.21	Warren.	
25, . .	12.38	3.27	9.11		
26, . .	12.67	3.79	8.88		
27, . .	13.85	4.38	9.47	Warren.	
28, . .	12.99	3.94	9.05		
29, . .	12.46	3.89	8.57		
30, . .	14.14	4.75	9.39	Warren.	
31, . .	13.17	3.65	9.52		
32, . .	13.14	4.33	8.81		
33, . .	12.84	4.61	8.23	Barre Plains.	
34, . .	11.95	3.62	8.33		
35, . .	13.10	4.22	8.88		
36, . .	10.58	2.79	7.79	Barre Plains.	
37, . .	13.52	4.73	8.79		
38, . .	12.21	3.85	8.36		

6. *Miscellaneous Analyses* — Concluded.*Analyses of Milk, etc.* — Concluded.

Number of Sample.	Solids.	Fat.	Solids not Fat.	Locality.	Remarks.
39, . .	12.19	3.63	8.56	Belchertown.	
40, . .	13.65	4.65	9.00	} Barre Plains.	
41, . .	13.35	4.42	8.93		
42, . .	14.24	4.69	9.55		
43, . .	13.08	4.17	8.91		
44, . .	12.38	3.19	9.19		
45, . .	16.87	6.37	10.50	} New Braintree.	
46, . .	15.16	5.81	9.35		
47, . .	16.46	6.76	9.70		
48, . .	16.00	6.51	9.49		
49, . .	15.41	6.13	8.28		
50, . .	16.61	7.33	9.28	} Barre Plains.	
51, . .	15.31	5.58	9.73		
52, . .	16.05	6.40	9.65		
53, . .	13.04	4.63	8.41		
54, . .	12.72	3.83	8.89		
55, . .	11.10	3.27	7.83	} North Adams. North Adams. Northborough.	
56, . .	11.28	3.59	7.69		
57, . .	11.68	4.78	6.90		
58, . .	11.15	3.91	7.24		
59, . .	13.32	4.62	8.70		
60, . .	12.29	4.56	7.73		
61, . .	15.23	6.92	8.31		
62, . .	13.25	4.25	9.00		

## II. ANALYSES OF WATER SENT ON FOR EXAMINATION.

[Parts per Million.]

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
1	.084	.116	24.00	86.00	56.00	2.60	None.	BillERICA.
2	.096	.144	16.00	80.00	50.00	-	-	Upton.
3	.120	.128	10.00	94.00	54.00	-	-	Upton.
4	.080	.136	5.00	12.00	6.00	-	-	Upton.
5	.112	.296	36.00	308.00	152.00	-	-	Upton.
6	.072	.104	4.00	86.00	60.00	2.86	None.	Amherst.
7	.052	.828	Trace.	86.00	20.00	1.27	None.	Sunderland.
8	.026	.070	8.00	98.00	44.00	1.27	-	Methuen.
9	.060	.108	Trace.	50.00	20.00	.95	None.	Cooleyville.
10	.068	.168	144.00	606.00	214.00	8.86	None.	North Amherst.
11	.020	.060	16.00	96.00	36.00	3.90	None.	Amherst.
12	.088	.092	84.00	150.00	96.00	2.60	None.	Plainville.
13	.640	.328	20.00	112.00	8.00	3.90	None.	Amherst.
14	-	-	56.00	-	-	-	-	Amherst.
15	-	-	24.00	-	-	-	-	Amherst.
16	.052	.136	Trace.	82.00	72.00	.16	None.	Westford.
17	.060	.140	Trace.	100.00	36.00	1.95	None.	Amherst.
18	.092	.204	Trace.	74.00	56.00	2.60	-	Amherst.
19	.140	1.480	48.00	322.00	48.00	5.29	None.	Weston.
20	.172	.176	12.00	146.00	26.00	2.60	None.	Amherst.
21	.050	.080	Trace.	56.00	26.00	1.27	Present.	Cooleyville.
22	.068	.072	Trace.	58.00	30.00	1.27	None.	Leverett.
23	.144	.120	Trace.	44.00	24.00	.32	None.	Westford.
24	.080	.148	28.00	314.00	154.00	6.00	None.	Natick.
25	.060	.052	20.00	154.00	86.00	4.57	None.	Amherst.
26	.108	.156	20.00	254.00	90.00	5.00	-	Agawam.
27	None.	.030	14.00	120.00	50.00	3.25	None.	North Amherst.
28	.040	.140	14.00	84.00	14.00	3.90	None.	Amherst.
29	.120	.080	8.00	80.00	50.00	1.27	None.	North Amherst.
30	-	-	-	-	-	-	Present.	North Amherst.
31	.200	.172	10.00	-	-	-	-	North Amherst.
32	.120	.072	Trace.	80.00	46.00	3.25	None.	Amherst.
33	1.680	.096	60.00	364.00	74.00	6.71	None.	Sunderland.



II. ANALYSES OF WATER, ETC. — *Concluded.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
34	.112	.140	12.00	90.00	80.00	5.25	None.	Amherst.
35	.112	.180	46.00	210.00	80.00	3.25	-	North Hadley.
36	.076	.118	Trace.	40.00	10.00	1.27	Present.	North Amherst.
37	.296	.240	20.00	314.00	74.00	-	-	Amherst.
38	.016	.264	Trace.	88.00	10.00	1.95	Present.	Graniteville.
39	.014	.140	12.00	58.00	16.00	2.60	None.	Athol.
40	.020	.088	8.00	20.00	6.00	1.95	-	North Amherst.
41	.100	.070	2.00	90.00	20.00	2.60	-	North Amherst.
42	.010	.066	4.00	32.00	6.00	.48	None.	Cooleyville.
43	.016	.132	8.00	130.00	70.00	2.60	None.	Sunderland.
44	.074	.098	6.00	50.00	6.00	1.95	-	Amherst.
45	.020	.066	170.00	608.00	378.00	12.56	None.	Amherst.
46	.012	.066	2.00	258.00	176.00	14.84	None.	Richmond.
47	.040	.084	9.00	174.00	84.00	6.00	None.	North Hadley.
48	None.	.106	4.00	62.00	16.00	.48	None.	Amherst.
49	.108	.180	4.00	130.00	70.00	1.95	None.	West Brookfield.
50	.140	.120	27.00	216.00	116.00	6.00	None.	Foxborough.
51	.040	.230	16.00	178.00	74.00	9.57	None.	Amherst.
52	.010	.066	Trace.	90.00	54.00	2.99	None.	Amherst.
53	None.	.084	20.00	252.00	72.00	4.57	None.	Amherst.
54	.112	.140	7.00	136.00	56.00	2.60	-	Blackstone.
55	.120	.120	11.00	170.00	70.00	5.29	-	Amherst.
56	.128	.180	4.00	126.00	46.00	3.25	-	Amherst.
57	.038	.150	4.00	84.00	24.00	2.60	-	Hadley.
58	.024	.092	8.00	94.00	54.00	2.60	None.	North Hadley.
59	None.	.200	2.00	46.00	20.00	.48	-	Hawley.
60	.096	.128	6.00	130.00	30.00	1.95	-	Amherst.
61	None.	.170	Trace.	160.00	90.00	1.27	-	Moore's Corner.
62	.018	.098	13.00	180.00	90.00	6.71	None.	Springfield.
63	.014	.070	3.00	34.00	20.00	1.95	None.	Rutland.
64	.080	.148	6.00	114.00	44.00	1.95	-	Westhampton.
65	.004	.100	4.00	116.00	40.00	.48	None.	Belchertown.
66	.990	.440	15.00	164.00	54.00	2.47	None.	Weston.
67	.080	.270	9.00	105.00	45.00	2.73	None.	Weston.
68	.260	.964	34.00	237.00	130.00	-	-	Grafton.

The analyses have been made according to Wancklyn's process, familiar to chemists, and are directed towards the indication of the presence of chlorine, free and albuminoid ammonia, and the poisonous metals, lead in particular. (For a more detailed description of this method, see "Water Analyses," by J. A. Wancklyn and E. T. Chapman.)

Mr. Wancklyn's interpretation of the results of his mode of investigation is as follows:—

1. Chlorine alone does not necessarily indicate the presence of filthy water.

2. Free and albuminoid ammonia in water, without chlorine, indicates a vegetable source of contamination.

3. More than five grains per gallon\* of chlorine (= 71.4 parts per million), accompanied by more than .08 parts per million of free ammonia and more than .10 parts per million of albuminoid ammonia, is a clear indication that the water is contaminated with sewage, decaying animal matter, urine, etc., and should be condemned.

4. Eight-hundredths parts per million of free ammonia and one-tenth part per million of albuminoid ammonia render a water very suspicious, even without much chlorine.

5. Albuminoid ammonia, over .15 parts per million, ought to absolutely condemn a water which contains it.

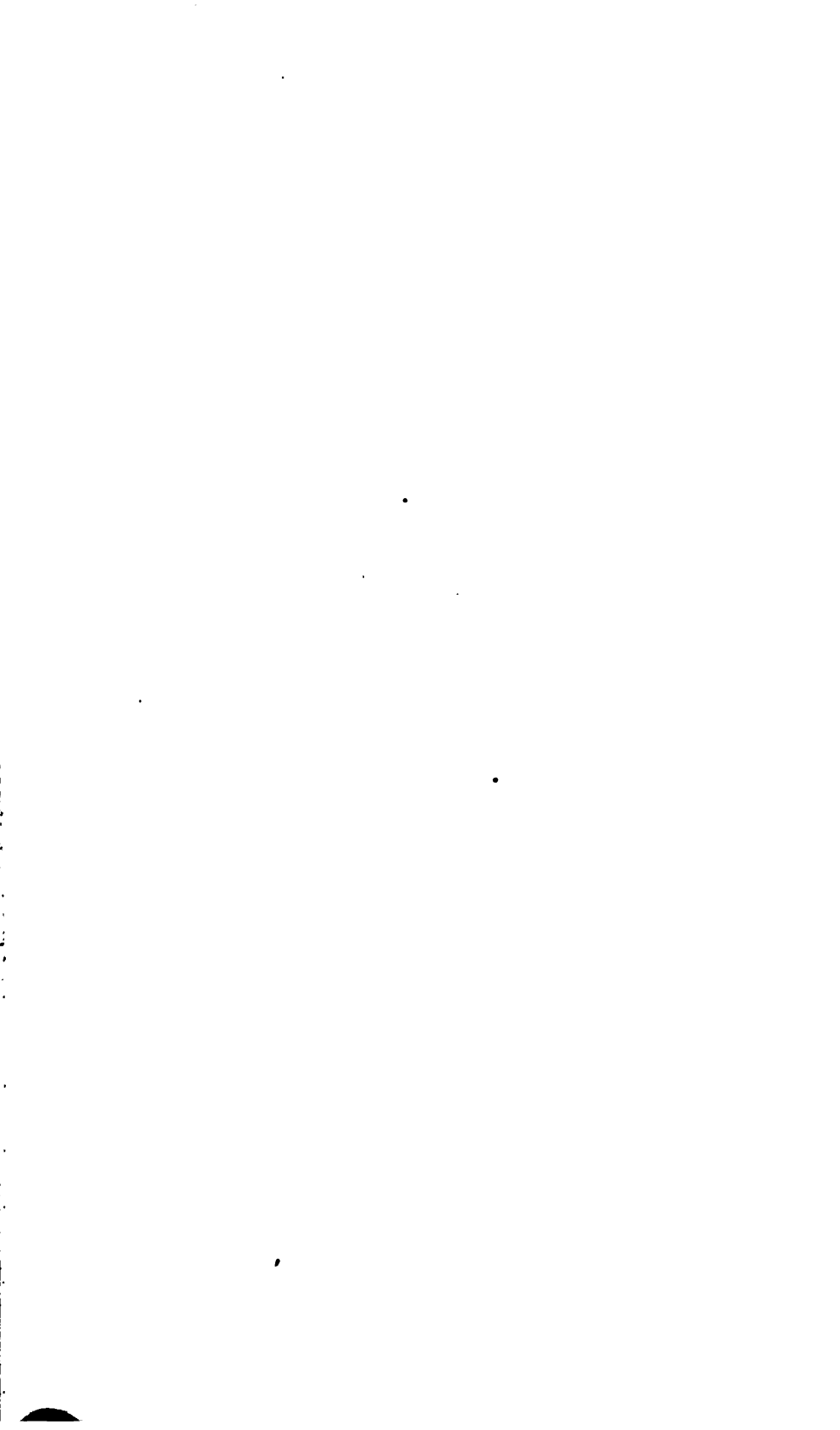
6. The total solids found in the water should not exceed forty grains per gallon (571.4 parts per million).

An examination of the previously stated analyses indicates that Nos. 1, 2, 3, 4, 5, 10, 13, 18, 19, 20, 23, 24, 26, 29, 31, 32, 33, 34, 35, 37, 49, 50, 54, 55, 56, 60, 66, 67 and 68 ought to be condemned as unfit for family use; while Nos. 6, 9, 12, 16, 17, 22, 36, 41, 44 and 64 must be considered suspicious. From this record it will be seen that over two-fifths of the entire number of well waters tried proved unfit for drinking. Heating waters to the boiling point removes not unfrequently immediate danger.

Parties sending on water for analysis ought to be very careful to use clean vessels, clean stoppers, etc. The samples should be sent on without delay after collecting. One gallon is desirable for the analysis.

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\* One gallon equals 70,000 grains.



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### III. COMPILATION OF ANALYSES MADE AT AMHERST, MASS., OF AGRICULTURAL CHEMICALS AND REFUSE MATERIALS USED FOR FERTILIZING PURPOSES.

PREPARED BY R. B. MOORE.

[As the basis of valuation changes from year to year, no valuation is stated.]

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1868-1892.

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This compilation does not include the analyses made of licensed fertilizers. They are to be found in the reports of the State Inspector of Fertilizers from 1873 to 1891, contained in the reports of the Secretary of the Massachusetts State Board of Agriculture for those years.

C. A. G.

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Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phos- phoric Acid.			Soluble Phosphoric Acid.	Reverted Phos- phoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Alumi- nic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.	
			Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
<i>I. Chemicals, Refuse, Salts, Ashes, etc.</i>																						
Muriate of potash, . . . . .	57	2.00	-	-	-	58.98	45.94	51.48	-	-	-	-	-	0.60	-	.55	-	-	-	48.80	.70	
Sulphate of potash, . . . . .	20	2.54	-	-	-	51.28	21.36	33.40	-	-	-	-	-	4.46	-	1.50	-	45.72	-	-	.75	
Sulphate of potash and magnesia, . . . . .	15	4.75	-	-	-	29.48	16.96	23.50	-	-	-	-	-	6.25	2.57	-	44.25	-	2.60	1.41		
Kainite, . . . . .	4	3.20	-	-	-	16.48	12.51	13.54	-	-	-	-	-	18.97	1.15	9.80	20.25	33.25	2.18			
Carnallite, . . . . .	1	-	-	-	-	-	-	13.88	-	-	-	-	-	7.06	-	13.19	.56	-	41.56	-		
Krugite, . . . . .	1	4.82	-	-	-	-	-	8.42	-	-	-	-	-	5.27	12.45	8.79	31.94	-	6.63	14.96		
Sulphate of magnesia (Kieserite), . . . . .	9	22.70	-	-	-	-	-	-	-	-	-	-	-	-	2.82	17.30	-	36.10	-	6.78		
Nitrate of potash, . . . . .	2	1.93	-	14.58	11.60	13.08	45.02	44.76	45.19	-	-	-	-	-	-	-	-	-	-	-	-	
Nitrate of soda, . . . . .	22	1.40	-	16.01	14.44	15.70	-	-	-	-	-	-	-	35.50	-	-	-	-	.50	.50		
Sulphate of ammonia, . . . . .	24	1.00	-	21.68	19.70	20.50	-	-	-	-	-	-	-	-	-	-	60.00	-	-	-	-	
Saltpetre waste, . . . . .	11	2.60	-	3.30	.52	2.28	30.94	1.55	14.34	-	-	-	-	36.50	.75	.19	1.85	-	48.80	-	-	
Nitre salt-cake, . . . . .	2	6.03	-	-	-	2.23	-	-	.87	-	-	-	-	29.56	-	-	47.77	-	-	-	3.92	
Wood ashes, . . . . .	189	12.50	-	-	-	-	10.80	2.32	5.25	5.68	.51	1.70	-	-	-	34.00	8.40	.90	-	-	12.90	
Cotton-seed-hull ashes, . . . . .	30	7.80	-	-	-	-	42.12	9.91	22.50	13.67	2.89	8.50	-	-	-	9.60	10.75	1.50	-	-	11.50	
Ashes of spent tan-bark, . . . . .	3	3.61	-	-	-	-	2.87	1.14	2.04	2.77	.18	1.61	-	-	-	33.46	3.55	-	-	-	24.33	



	Analyses.	Moisture.	Ash.	NITROGEN.			POTASH.			TOTAL PHOS- PHORIC ACID.			Soluble Phosphoric Acid.	Reverted Phos- phoric Acid.	Insoluble Phos- phoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Alumi- nic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				NITROGEN.			POTASH.			TOTAL PHOS- PHORIC ACID.													
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
II. Guano, Phosphates, etc. — Concluded.																							
		5	1.50	-	-	-	-	-	-	30.51	25.81	28.03	.27	.07	27.60	-	41.87	3.03	4.80	-	-	-	9.04
	South Carolina rock phosphate, . . .	22	2.25	-	-	-	-	-	-	38.97	6.95	24.50	-	-	-	-	28.50	-	7.25	-	-	-	28.75
	Florida rock phosphate, . . .	2	7.00	-	-	-	-	-	-	34.45	34.09	34.27	-	-	-	-	37.45	-	10.27	-	-	-	2.70
	Navassa phosphate, . . .	1	2.50	-	-	-	-	-	-	-	-	35.21	-	-	-	-	-	-	-	-	-	-	6.46
	Brockville phosphate, . . .	4	1.45	-	-	-	-	-	-	30.51	18.91	23.46	-	3.06	21.65	-	48.66	3.42	10.12	-	-	-	9.40
	Phosphatic slag, . . .	2	7.50	47.50	-	-	-	-	-	17.54	15.35	16.45	15.60	.60	.19	-	-	-	-	-	-	-	1.50
	Dissolved bone-black, . . .	5	4.00	-	-	-	-	-	-	30.54	16.56	23.28	-	-	-	-	-	-	-	-	-	-	3.64
	Bone-black, . . .	1	7.00	-	-	-	-	-	-	-	-	35.88	-	-	-	-	44.89	-	-	-	-	-	4.50
	South American bone-ash, . . .	1	14.22	60.95	-	-	-	-	-	-	-	14.64	10.34	2.42	1.88	-	-	-	-	-	-	-	10.81
	Acid phosphate, . . .																						
III. Refuse Substances.																							
	Dried blood, . . .	14	12.50	6.37	13.55	8.10	10.52	-	-	-	6.23	1.63	1.91	-	-	-	-	-	-	-	-	-	-
	Ammonite, . . .	1	5.88	-	-	11.33	-	-	-	-	-	3.43	-	-	-	-	-	-	-	-	-	-	1.35
	Oleomargarine refuse, . . .	1	8.54	14.42	-	12.12	-	-	-	-	-	.86	-	-	-	-	-	-	-	-	-	-	.96
	Felt refuse, . . .	1	29.24	33.53	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sponge refuse, . . .	1	7.25	-	-	2.43	-	-	-	-	-	3.18	-	-	-	-	9.94	1.27	-	-	-	-	26.05

Horn and hoof waste, . . . . .	8.10.17	7.63	15.49	11.64	13.25	-	-	2.30	1.36	1.83	-	-	-	-	-	-	-	.24
Raw wool, . . . . .	1	6.95	7.54	-	12.88	-	-	-	-	-	-	-	-	-	-	-	-	3.63
Wool waste, . . . . .	7	15.80	24.10	10.20	1.03	5.70	3.08	-	-	-	-	-	-	-	-	-	-	8.20
Wool washings (water), . . . . .	1	-	-	-	-	-	-	.06	1.20	.67	.05	.38	-	-	.11	.06	.80	-
Wool washings (acid), . . . . .	1	-	-	-	-	-	-	-	3.92	-	-	-	-	-	.49	.28	-	-
Wool washings (alkaline), . . . . .	1	-	-	-	-	-	-	-	4.20	-	-	-	-	-	.40	.61	.20	-
Meat mass, . . . . .	1	92.03	3.28	-	-	.09	-	-	1.09	-	-	-	-	-	.92	.04	-	.22
Bone soup, . . . . .	5	12.09	13.60	11.50	9.60	10.44	-	-	-	3.58	.56	2.07	-	-	-	-	-	.58
Dried soup from meat and bone, . . . . .	1	82.92	7.07	-	-	1.14	-	-	-	-	-	1.26	-	-	-	-	-	-
Dried soup from rendering cattle feet, . . . . .	1	14.80	8.40	-	-	9.97	-	-	-	-	-	.53	-	-	-	-	-	.64
Dried soup from horse rendering, . . . . .	1	10.80	7.50	-	-	14.47	-	-	-	-	-	.48	-	-	-	-	-	.26
Soap-grease refuse, . . . . .	1	92.14	-	-	-	1.12	-	-	-	-	-	.14	-	-	-	-	-	-
Bones, . . . . .	2	29.25	51.39	4.20	2.21	3.21	-	-	-	15.37	11.04	13.21	-	-	-	-	-	1.29
Tankage, . . . . .	134	7.50	55.90	4.70	1.62	4.05	-	-	-	32.52	15.16	23.25	.40	7.60	15.75	-	-	1.10
Fish with less than twenty per cent. water, . . . . .	16	12.50	30.40	8.07	4.16	6.65	-	-	-	18.86	7.39	11.25	.30	5.10	5.85	-	-	1.35
Fish with between twenty and forty per cent. water, . . . . .	59	12.75	21.50	11.40	6.81	7.25	-	-	-	11.26	5.50	8.25	.65	2.60	5.10	-	-	2.20
Fish with more than forty per cent. water, . . . . .	9	29.34	19.14	7.41	4.22	5.81	-	-	-	8.32	4.68	7.25	.82	2.87	3.56	-	-	1.85
Whale meat, raw, . . . . .	10	45.46	15.50	7.60	2.43	4.97	-	-	-	8.56	2.94	5.08	1.17	1.33	2.58	-	-	1.35
Lobster shells, . . . . .	1	44.50	1.04	-	-	4.86	-	-	-	-	-	-	-	-	-	-	-	-
Castor-bean pomace, . . . . .	1	7.27	-	-	-	4.50	-	-	-	-	-	-	-	-	-	-	-	.27
Cotton-seed meal, . . . . .	4	9.98	5.70	5.72	5.33	5.56	1.70	.64	1.12	2.22	1.57	2.16	-	-	.87	.29	-	1.75
Rotten brewer's grain, . . . . .	13	7.75	5.90	7.26	4.02	6.55	2.09	.80	1.70	3.36	1.26	2.10	-	-	.39	.99	-	.40
	1	78.77	-	-	-	.72	-	-	.04	-	-	.49	-	-	.26	.15	-	.59





Blue-green algae ( <i>Lyngbia majuscula</i> ), dry,	1	16.26	-	-	-	-	-	-	-	-	-	3.53	2.06	1.18	-	-	5.68
Mussel mud, wet,	1	60.01	27.26	-	-	.21	-	-	-	.10	-	.70	.93	.14	3.48	-	-
Mussel mud, dry,	1	2.24	72.02	-	-	.72	-	-	-	.35	-	-	23.39	-	8.26	-	37.60
Salt mud,	2	53.87	41.19	.40	.39	.40	.33	.32	.33	-	-	.94	.91	.37	4.13	-	34.88
Fresh-water mud,	1	40.37	-	-	-	1.37	-	.22	.22	.26	-	-	1.27	.29	1.80	-	18.26
Muck,	14	57.50	13.75	2.54	.26	1.05	-	-	.17	.08	.13	-	-	-	-	-	11.85
Peat,	10	61.50	8.20	1.40	.41	.85	-	-	.18	-	.08	-	.52	.72	2.14	-	2.20
Turf,	2	19.29	6.96	1.97	1.91	1.94	-	-	-	-	-	-	-	-	-	-	-
Soot,	1	5.54	77.10	-	-	-	-	-	1.83	-	-	-	-	-	-	-	35.94
<i>IV. Animal Excrement, etc.</i>																	
Barn-yard manure,	24	68.87	8.36	.67	.26	.49	.80	.13	.43	.75	.13	.32	.30	.19	-	-	5.40
Pondrette, dry,	1	5.25	35.45	-	-	3.58	-	-	.49	-	-	5.74	-	-	-	-	4.65
Hen manure, fresh,	2	52.35	24.75	1.20	.79	.89	.32	.18	.25	1.00	.47	.74	1.19	.89	1.24	-	23.50
Hen manure, dry,	1	8.35	-	-	-	2.13	-	-	9.94	-	-	2.02	2.22	.62	-	-	34.64



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IV. COMPILATION OF ANALYSES OF FODDER ARTICLES,  
FRUITS, SUGAR-PRODUCING PLANTS, DAIRY  
PRODUCTS, ETC.,

MADE AT

AMHERST, MASS.

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1868-1892.

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PREPARED BY R. B. MOORE.

- A. ANALYSES OF FODDER ARTICLES.
  - B. ANALYSES OF FODDER ARTICLES WITH REFERENCE  
TO FERTILIZING INGREDIENTS.
  - C. ANALYSES OF FRUIT.
  - D. ANALYSES OF SUGAR-PRODUCING PLANTS.
  - E. DAIRY PRODUCTS.
  - F. INSECTICIDES.
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## A. Analyses of Fodder Articles.

NAME.	Analyses.	ONE HUNDRED PARTS OF DRY MATTER CONTAIN —																Nitrifying Ratio (Average).			
		DRY MATTER.				PROTEIN.				FAT.				NITROGEN-FREE EXTRACT.					Ash.		
		Max.		Min.		Aver.		Max.		Min.		Aver.		Max.		Min.				Aver.	
<i>I. Green Fodders.</i>																					
Fodder corn, . . . . .	24	30.53	10.33	19.50		17.19	7.62	10.22		0.10	1.42		2.41	63.13	42.02	55.59	31.53	19.26	25.90	5.88	1:8.10
Fodder corn ensilage, . . . . .	30	37.43	13.12	22.25		12.58	5.08	8.12		0.40	1.82		3.83	65.60	42.90	55.26	38.92	17.67	27.44	5.35	1:10.22
Corn and soya bean ensilage, . . . . .	1	—	—	28.97		—	—	15.27		—	—		5.35	—	—	40.50	—	—	37.84	11.04	1:5.32
Sorghum, . . . . .	6	23.18	12.38	17.41		11.84	7.46	8.74		2.00	1.21		1.55	64.93	47.65	56.15	29.27	22.00	26.73	6.83	1:11.85
Common millet, . . . . .	9	49.29	21.32	35.42		12.16	5.43	7.50		3.99	2.09		2.74	58.61	46.30	53.89	33.98	24.88	30.99	4.84	—
Japanese millet (white head), . . . . .	3	26.24	20.05	24.76		10.98	7.26	8.72		2.64	1.94		2.33	50.87	46.71	49.60	38.90	30.12	34.47	4.88	—
Japanese millet (red head), . . . . .	6	33.83	22.66	27.33		7.99	4.92	6.30		2.45	1.68		2.01	60.83	50.11	52.91	35.20	25.21	32.10	6.08	—
White kibi, . . . . .	2	24.26	22.85	23.56		15.14	10.79	12.37		1.67	1.60		1.56	53.06	52.30	52.91	31.70	23.03	27.37	5.19	—
Moehl millet, . . . . .	3	42.29	30.07	37.42		11.90	6.11	9.94		1.94	1.74		1.81	67.08	49.06	55.69	29.80	30.01	25.56	7.00	—
Mix., . . . . .	3	31.96	18.17	24.45		16.70	9.81	13.53		2.48	1.35		1.86	52.30	47.75	51.27	27.44	26.82	27.06	6.28	—
Green oats, . . . . .	5	28.82	16.31	20.03		20.47	7.05	13.85		3.32	2.02		2.68	50.60	40.81	45.90	33.12	25.20	29.70	7.87	1:9.97
Timothy ( <i>Phleum pratense</i> L.), . . . . .	2	35.00	34.26	34.63		8.83	8.20	8.52		2.07	1.95		2.01	61.33	51.23	51.27	33.23	32.50	32.67	6.33	1:12.26
Hungarian grass ( <i>Setaria Italica</i> Beauv.), . . . . .	1	—	—	25.93		—	—	9.38		—	—		1.01	—	—	57.80	—	—	24.68	7.15	1:6.86
Vetch and oats (one part vetch and nine parts oats), . . . . .	3	24.04	13.49	18.97		10.76	8.83	10.06		2.74	2.29		2.53	49.85	40.10	44.75	35.81	30.77	33.59	9.07	1:7.06
Horse bean, whole plant ( <i>Vicia faba</i> L.), . . . . .	1	—	—	15.17		—	—	16.68		—	—		2.31	—	—	47.09	—	—	28.17	6.75	1:2.71
Soya bean (whole plant, <i>Soya Aspidica</i> Münch), . . . . .	10	30.20	18.54	23.58		22.10	13.71	16.45		8.98	2.71		4.84	47.30	40.80	44.50	31.80	31.07	25.47	7.74	1:4.20

Cow-pea vines ( <i>Dolichos sinensis</i> L.),	3	21.19	18.15	19.63	17.93	11.24	14.53	2.99	1.81	2.46	60.02	46.13	52.42	25.89	21.87	23.59	6.92	1:6.82
Serradella ( <i>Ornithopus sativus</i> Brot.),	2	19.42	15.40	17.41	17.75	12.17	14.96	2.65	2.09	2.37	41.54	35.45	38.46	38.76	29.21	32.49	11.60	1:4.67
White lupine ( <i>Lupinus albus</i> L.),	1	-	-	14.65	-	-	18.71	-	-	2.41	-	-	42.67	-	-	31.18	5.03	-
Spanish moss ( <i>Tillandsia usneoides</i> L.),	1	-	-	39.20	-	-	4.45	-	-	2.54	-	-	57.73	-	-	32.61	2.67	-
<i>II. Hay and Dry Coarse Fodders.</i>																		
English hay (mixed hay),	10	91.94	86.96	89.73	11.93	8.47	9.80	2.77	1.56	2.30	54.72	47.11	50.03	35.55	29.21	31.90	6.17	1:11.83
Rowen of mixed hay,	14	91.16	75.55	81.93	14.70	11.63	12.75	5.03	2.60	3.56	53.62	41.92	50.00	31.50	24.25	26.39	7.30	1:6.83
Timothy hay,	6	92.76	81.26	89.39	9.37	7.24	8.66	2.65	1.95	2.22	54.43	50.01	51.55	36.59	29.21	32.90	4.88	1:11.94
Red-top hay ( <i>Agrostis vulgaris</i> With.),	4	93.19	91.76	92.30	8.40	6.41	7.88	1.69	1.50	1.80	54.74	50.32	52.63	34.11	31.12	32.92	4.97	1:12.06
Kentucky blue-grass ( <i>Poa pratensis</i> L.),	2	96.10	93.22	94.66	8.78	8.65	8.72	2.08	2.03	2.06	49.61	44.11	46.29	36.84	32.21	34.56	8.35	1:10.38
Orchard grass ( <i>Dactylis glomerata</i> L.),	4	91.62	90.86	91.17	11.29	7.57	8.99	3.56	2.40	2.91	47.34	43.50	46.15	35.79	34.12	34.89	7.06	1:10.47
Meadow fescue ( <i>Festuca pratensis</i> Huds.),	6	94.70	87.84	91.09	7.85	5.89	6.76	2.17	1.63	1.87	49.18	42.03	46.31	39.90	34.61	36.93	8.13	1:13.69
Perennial rye-grass ( <i>Lolium perenne</i> L.),	4	93.64	90.50	92.60	16.56	6.59	11.71	3.15	1.59	2.37	55.77	38.82	46.14	30.86	26.79	29.64	8.14	1:7.40
Italian rye-grass ( <i>Lolium italicum</i> A. Br.),	4	92.62	90.70	91.54	9.75	6.20	8.15	2.07	1.39	1.85	52.90	43.09	49.14	36.90	31.27	33.94	7.62	1:10.90
Hungarian grass,	1	-	-	92.55	-	-	9.45	-	-	2.22	-	-	50.64	-	-	31.96	5.73	1:6.22
Barn-yard grass ( <i>Panicum crus-galli</i> L.),	1	-	-	93.35	-	-	15.27	-	-	1.95	-	-	30.24	-	-	33.72	10.02	1:2.94
Hay of black grass,	1	-	-	91.25	-	-	6.72	-	-	3.37	-	-	49.47	-	-	31.41	9.03	-
Low meadow hay,	1	-	-	91.99	-	-	9.51	-	-	1.88	-	-	46.27	-	-	35.59	6.75	-
Salt hay,	2	91.92	90.34	91.13	4.35	3.77	4.06	3.24	2.63	2.95	60.15	60.14	60.15	27.84	27.82	27.83	5.02	-
Millst,	6	93.85	90.25	92.54	8.88	7.09	7.81	3.63	.89	2.05	55.80	49.62	51.74	35.91	29.80	33.32	5.08	1:7.78
Oats in bloom,	1	-	-	93.57	-	-	6.56	-	-	2.92	-	-	50.03	-	-	34.06	6.41	1:14.23
Oats in milk,	1	-	-	90.45	-	-	10.89	-	-	2.69	-	-	46.02	-	-	34.32	6.08	1:7.90

## A. Analyses of Fodder Articles — Continued.

N A M E.	Analyses.	ONE HUNDRED PARTS OF DRY MATTER CONTAIN —														Nutritive Ratio (Average).		
		DRY MATTER.			PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.				Ash.			
		Max.		Aver.	Max.		Aver.	Max.		Aver.	Max.		Aver.	Max.			Aver.	
		Min.		Min.		Min.		Min.		Min.		Min.						
II. Hay and Dry Coarse Fodders — Concluded.																		
Oats, ripe, . . . . .	1	—	—	91.30	—	—	6.05	—	—	2.61	—	—	48.92	—	—	36.31	6.11	1:15.03
Winter rye in bloom, . . . . .	1	—	—	91.45	—	—	10.66	—	—	2.57	—	—	47.40	—	—	32.97	6.40	1:8.28
Barley in milk, . . . . .	1	—	—	89.75	—	—	10.26	—	—	2.76	—	—	52.91	—	—	29.12	4.95	1:9.69
Japanese buckwheat, . . . . .	1	—	—	94.29	—	—	10.80	—	—	2.22	—	—	38.60	—	—	36.02	12.36	—
Dry fodder corn, . . . . .	4	93.35	90.58	92.11	9.31	6.17	7.74	2.76	1.11	1.04	58.89	53.86	55.97	33.75	23.03	29.31	5.14	1:10.98
Corn stover, . . . . .	26	94.44	76.00	88.18	12.15	5.46	7.29	2.63	1.08	1.38	53.05	44.05	50.82	38.83	20.93	34.84	5.67	1:11.63
Teosinte ( <i>Euchlana hazuriana</i> Dur. and Aesch.), . . . . .	1	—	—	93.94	—	—	9.71	—	—	1.28	—	—	53.18	—	—	28.88	6.95	—
Mammoth red clover ( <i>Trifolium medium</i> L.), . . . . .	3	92.66	82.47	88.59	18.50	14.06	15.75	2.25	1.86	2.13	48.08	46.51	44.77	33.72	20.16	27.51	9.84	1:5.10
Medium red clover ( <i>Trifolium pratense</i> L.), . . . . .	2	94.90	93.98	94.44	15.01	14.63	14.82	2.62	2.56	2.49	43.88	42.81	43.34	30.76	29.97	30.37	8.98	1:5.62
Alsike clover ( <i>Trifolium hybridum</i> L.), . . . . .	6	93.92	86.48	90.07	17.55	14.77	16.63	3.26	1.88	2.58	46.64	38.03	42.72	32.34	21.44	28.17	11.90	1:3.26
Lucerne (alfalfa) ( <i>Medicago sativa</i> Desr.), . . . . .	5	95.40	84.00	81.40	16.34	11.12	14.22	2.60	1.04	1.65	51.62	46.25	46.20	34.39	25.42	29.72	6.11	1:4.09
Sand lucerne ( <i>Medicago media</i> Pers.), . . . . .	1	—	—	91.20	—	—	16.26	—	—	2.59	—	—	50.31	—	—	21.27	9.57	1:3.60
Bokhar clover ( <i>Melilotus alba</i> Desr.), . . . . .	2	93.64	91.50	92.57	14.93	11.81	13.37	4.70	1.85	3.32	51.36	38.83	45.08	35.05	28.08	30.57	7.00	—
Blue melilot ( <i>Melilotus coarctata</i> Desr.), . . . . .	1	—	—	91.78	—	—	13.81	—	—	1.67	—	—	43.22	—	—	27.17	14.87	—
Sainfoin ( <i>Onobrychis sativa</i> ), . . . . .	1	—	—	87.83	—	—	17.70	—	—	4.49	—	—	42.27	—	—	26.95	8.64	—
Sulla ( <i>Hedysarum coronarium</i> ), . . . . .	2	91.68	89.50	90.61	17.03	16.90	16.97	3.16	2.36	2.78	58.66	41.89	50.26	28.05	12.38	20.67	9.32	—

Hairy lotus ( <i>Lotus villosus</i> Thunb.),	2	89.32	87.64	86.46	16.12	13.49	14.81	3.00	2.69	2.85	67.82	50.80	54.29	24.48	15.07	19.78	8.27	-
Soja bean,	3	93.88	79.91	89.10	19.06	16.10	16.68	8.33	5.62	6.77	51.28	41.09	46.96	25.84	20.76	22.78	6.90	1:4.23
Cow pea,	3	90.70	90.25	90.43	17.17	16.95	17.05	4.49	3.81	4.06	51.41	46.06	47.93	23.68	19.06	21.67	9.29	1:4.82
Small pea ( <i>Lathyrus sativus</i> ),	1	-	-	94.20	-	-	16.57	-	-	1.46	-	-	42.76	-	-	32.88	6.30	-
Serradella,	3	92.80	87.23	90.44	17.97	15.26	17.03	2.91	2.37	2.55	50.23	44.49	46.16	25.92	24.37	25.15	7.09	1:4.85
Hairy vetch ( <i>Vicia villosa</i> Roth.),	1	-	-	92.56	-	-	19.58	-	-	1.22	-	-	38.95	-	-	31.88	8.37	-
Common vetch ( <i>Vicia sativa</i> L.),	2	91.65	90.55	91.10	15.76	14.42	15.09	2.69	2.30	2.50	44.34	43.29	43.80	30.48	30.05	30.37	8.24	1:3.87
Scotch tares,	1	-	-	84.20	-	-	22.00	-	-	1.99	-	-	31.46	-	-	30.89	13.76	-
Vetch and oats,	2	94.22	87.47	90.85	7.72	7.70	7.71	3.37	2.53	2.95	49.95	49.00	49.47	36.22	31.73	33.98	5.80	1:11.49
Horse-bean straw,	1	-	-	90.85	-	-	9.69	-	-	1.51	-	-	37.77	-	-	41.44	9.59	1:8.55
Soja-bean straw,	1	-	-	87.00	-	-	5.39	-	-	1.80	-	-	43.72	-	-	43.85	5.24	-
White daisy ( <i>Chrysanthemum leucanthemum</i> L.),	1	-	-	90.35	-	-	7.68	-	-	2.32	-	-	46.86	-	-	36.09	7.06	-
Dry carrot tops,	1	-	-	90.24	-	-	20.12	-	-	2.01	-	-	50.39	-	-	13.61	13.87	-
Wheat straw,	1	-	-	93.80	-	-	7.20	-	-	1.63	-	-	50.46	-	-	35.81	4.80	1:8.00
Barley straw,	1	-	-	88.56	-	-	9.24	-	-	3.38	-	-	49.23	-	-	33.85	5.30	1:26.21
Japanese millet (white head),	1	-	-	91.46	-	-	7.67	-	-	2.41	-	-	49.87	-	-	34.89	5.06	-
Japanese millet (red head),	1	-	-	91.13	-	-	5.76	-	-	1.70	-	-	49.66	-	-	33.52	3.36	-
III. Roots, Bulbs, Tubers, etc.																		
Beets, red,	7	14.51	9.75	12.17	15.40	7.82	12.29	1.76	.59	.94	79.33	66.87	72.19	7.56	4.29	6.00	8.58	1:8.24
Beets, sugar,	11	19.53	9.87	14.73	17.44	7.32	10.97	.83	.58	.66	81.50	61.93	75.93	9.69	4.82	6.49	5.95	1:11.80
Mangolds,	3	13.08	11.73	12.95	12.84	7.83	10.37	1.01	.73	.88	73.38	70.32	71.75	9.54	7.08	7.94	9.06	1:8.83
Beets, yellow fodder,	1	-	-	9.40	-	-	12.78	-	-	1.80	-	-	67.50	-	-	7.83	10.09	1:9.94



## A. Analyses of Fodder Articles — Continued.

NAME.	Analyses.	ONE HUNDRED PARTS OF DRY MATTER CONTAIN —																Nutritive Ratio (Average).
		DRY MATTER.			PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.	
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
III. Roots, Bulbs, Tubers, etc. — Concluded.																		
Ruta-baga,	3	12.77	8.25	10.88	11.46	10.34	11.01	2.32	1.23	1.53	68.68	62.27	65.68	13.12	11.03	11.83	9.75	1:11.83
Turnips,	3	12.80	8.22	8.79	10.81	9.07	10.12	2.05	1.42	1.74	70.62	65.91	68.44	12.61	10.12	11.23	8.47	1:13.26
Carrots,	4	12.62	9.95	10.72	9.63	7.98	8.83	3.94	1.67	2.34	73.96	67.24	71.27	10.76	7.55	9.19	8.27	1:9.67
Parnips,	1	—	—	19.66	—	—	6.88	—	—	3.37	—	—	74.65	—	—	—	7.67	—
Potatoes,	10	21.95	13.91	18.78	13.66	6.24	10.01	.83	.17	.48	87.56	78.80	81.50	3.85	1.91	2.75	5.26	1:12.25
Apples,	2	24.83	19.68	22.28	4.57	3.92	4.25	2.81	1.71	2.26	86.21	83.44	84.81	7.06	6.14	6.80	2.08	1:26.44
IV. Grains and Other Seeds.																		
Corn kernels,	28	91.98	65.50	88.55	16.02	8.49	12.24	9.43	4.25	5.47	83.98	71.06	78.44	3.38	1.03	2.14	1.71	1:8.16
Corn and cob meal,	37	94.00	80.89	88.47	16.06	7.82	10.01	5.27	3.36	4.19	81.41	70.13	76.92	10.41	5.63	7.54	1.64	—
Wheat kernels,	1	—	—	88.42	—	—	13.35	—	—	1.79	—	—	80.20	—	—	2.42	2.18	1:6.42
Broom-corn seed,	1	—	—	85.80	—	—	11.21	—	—	4.05	—	—	74.05	—	—	8.34	2.35	—
Soja beans,	3	94.15	80.73	85.83	35.98	32.68	33.97	21.89	18.42	20.19	34.88	32.87	33.98	7.57	5.15	6.02	5.84	1:2.61
Horse beans,	1	—	—	88.72	—	—	30.03	—	—	1.11	—	—	56.46	—	—	9.11	4.27	1:2.24
Red adinkli beans,	2	85.18	83.10	84.14	25.14	23.76	24.45	.88	.76	.82	66.48	65.41	65.95	4.66	4.50	4.59	4.19	—
Saddle beans,	1	—	—	87.62	—	—	15.12	—	—	16.59	—	—	57.34	—	—	4.78	6.21	—

Dalton beans, . . . . .	1	-	-	68.47	-	-	36.98	-	-	18.58	-	-	30.41	-	-	4.97	7.04	-
Millet seed, . . . . .	3	87.32	86.11	86.65	14.60	11.76	13.24	4.04	3.53	4.32	73.19	66.94	70.56	10.23	6.48	8.98	3.00	-
Chestnuts, . . . . .	1	-	-	55.14	-	-	13.32	-	-	14.48	-	-	87.05	-	-	2.45	2.72	-
<i>V. Flour and Meal.</i>																		
Corn meal, . . . . .	27	89.95	82.96	85.98	16.08	9.73	11.08	5.08	3.10	4.50	83.24	73.20	80.53	3.60	1.20	2.19	1.70	-
Hominy meal, . . . . .	4	91.89	88.68	90.23	11.88	6.77	10.41	12.22	4.89	9.81	78.07	68.00	73.00	6.12	3.69	4.34	2.44	-
Ground barley, . . . . .	3	87.81	82.60	85.59	14.93	10.42	12.17	2.38	1.69	2.08	78.25	74.47	76.69	7.37	5.04	6.42	2.63	-
Broom-corn meal, . . . . .	1	-	-	88.48	-	-	11.14	-	-	4.13	-	-	74.30	-	-	8.00	2.43	-
Pea meal, . . . . .	1	-	-	91.15	-	-	20.95	-	-	1.87	-	-	55.02	-	-	19.42	2.94	-
<i>VI. By-products and Refuse.</i>																		
Linseed cake, old process, . . . . .	7	92.52	88.50	90.54	30.97	30.98	36.64	9.87	6.24	7.16	44.72	37.76	40.61	9.60	8.04	8.68	6.91	1:1.06
Linseed cake, new process, . . . . .	5	94.94	88.17	92.05	41.02	35.03	39.18	4.08	2.17	3.12	46.49	40.83	41.87	10.31	8.93	9.38	6.45	1:1.32
Cotton-seed meal, decorticated, . . . . .	14	93.16	88.81	91.32	51.79	36.54	44.43	14.72	9.57	12.23	33.87	20.22	27.18	10.83	6.28	8.11	8.05	1:1.39
Wheat bran, . . . . .	32	92.58	86.30	88.44	20.54	15.67	17.71	6.08	2.80	4.99	62.18	51.77	58.39	14.26	7.49	10.90	7.01	-
Wheat middlings, . . . . .	6	90.75	87.57	89.93	19.21	15.13	16.72	6.46	3.19	5.31	74.30	58.03	61.77	11.21	1.40	9.21	6.99	1:4.21
Rye bran, . . . . .	2	91.82	86.30	88.06	18.98	16.52	17.75	3.03	2.07	2.55	73.56	69.24	71.70	4.64	3.46	4.00	4.30	1:4.88
Rye middlings, . . . . .	1	-	-	87.46	-	-	13.15	-	-	5.81	-	-	73.52	-	-	3.70	4.02	1:7.28
Buckwheat middlings, . . . . .	1	-	-	88.49	-	-	25.48	-	-	7.53	-	-	66.36	-	-	5.18	5.44	-
Gluten meal, . . . . .	22	93.50	88.32	90.36	39.28	25.94	32.06	12.05	8.92	7.35	66.26	48.26	53.62	6.43	.41	1.28	.71	1:2.75
Malze feed, . . . . .	1	-	-	90.25	-	-	21.33	-	-	6.15	-	-	82.12	-	-	9.65	.75	1:4.49
Corn germ meal, . . . . .	1	-	-	90.65	-	-	28.28	-	-	11.82	-	-	42.49	-	-	9.18	8.25	-

## A. Analyses of Fodder Articles—Concluded.

NAME.	Analyses.	ONE HUNDRED PARTS OF DRY MATTER CONTAIN —												Nutritive Ratio (Average).				
		DRY MATTER.			PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.				Ash.			
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.					
VI. By-products and Refuse — Concluded.																		
Bakery refuse,	1	—	—	86.66	—	—	9.23	—	—	6.36	—	—	72.34	—	.43	11.64		
Vinegar mash,	1	—	—	5.51	—	—	16.50	—	—	8.45	—	—	63.47	—	8.55	3.03		
Refuse from starch works,	1	—	—	42.96	—	—	22.41	—	—	10.17	—	—	58.98	—	7.54	.90		
Spent brewer's grain,	4	93.02	83.00	90.13	33.16	16.08	23.28	6.29	1.95	4.89	67.62	42.32	54.04	15.90	8.07	11.25	4.53	1:2.90
Cocoa dust from cocoa manufactory,	1	—	—	92.90	—	—	15.47	—	—	25.85	—	—	45.99	—	5.86	6.83	—	
Broom-corn waste,	1	—	—	81.30	—	—	6.78	—	—	1.00	—	—	48.09	—	39.25	4.88	—	
Cotton hulls,	2	89.83	85.65	89.10	5.36	4.90	5.13	4.27	2.36	3.31	46.75	38.50	42.67	51.40	40.24	45.82	3.07	1:28.16
Apple pomace,	2	21.78	17.22	19.50	7.73	6.94	7.34	4.37	3.17	3.78	72.03	70.20	72.56	16.58	13.15	14.86	7.46	—
Apple pomace ensilage,	1	—	—	14.87	—	—	8.22	—	—	7.36	—	—	58.03	—	22.16	4.21	—	—
Sugar beet pulp, from diffusion battery,	1	—	—	10.32	—	—	12.41	—	—	.95	—	—	61.66	—	23.74	1.04	—	—
Corn cobs,	4	—	—	90.00	4.15	3.00	3.57	.67	.58	.57	63.62	60.58	61.78	53.77	31.36	32.83	1.21	1:50.85
Palmetto root,	1	—	—	86.49	—	—	3.82	—	—	.53	—	—	69.95	—	21.26	4.44	—	—

## B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
<i>I. Green Fodders.</i>												
Fodder corn, . . . . .	14	78.61	.407	4.84	.327	.048	.163	.091	.018	.146	.380	\$1 66
Fodder corn ensilage, . . . . .	1	71.60	.360	-	.330	.060	.100	.090	.020	.140	.040	1 58
Corn and soja bean ensilage, . . . . .	1	71.06	.760	-	.444	-	-	-	-	.420	-	3 23
Sorghum, . . . . .	7	82.19	.233	-	.229	.025	.076	.075	.012	.068	.136	1 00
White kibi, . . . . .	2	76.45	.466	1.22	.200	.045	.232	.148	.019	.136	.652	1 79
Mochi millet, . . . . .	3	62.58	.606	2.62	.407	.120	.201	.217	.021	.188	.705	2 50
Mix, . . . . .	3	75.59	.466	1.54	.363	.060	.249	.245	.021	.237	.527	2 08
Green oats, . . . . .	3	83.36	.466	1.31	.381	.217	.154	.134	.018	.130	.406	1 66
Vetch and oats, . . . . .	1	86.11	.236	1.72	.766	.031	.087	.080	.012	.064	.331	1 63
Horse bean, . . . . .	1	74.71	.675	-	1.370	.090	1.370	.620	.200	.330	2.040	3 62
Cow-pea vines, . . . . .	1	78.81	.274	1.47	.308	.063	.300	.099	.016	.088	.077	1 21
Serradella, . . . . .	2	82.59	.411	1.82	.420	.097	.400	.067	.021	.140	.097	1 77
White lupine, . . . . .	1	85.35	.440	-	1.730	.680	3.070	.730	.170	.360	.900	3 26
Spanish moss, . . . . .	1	60.80	.279	1.04	.256	.263	.089	.122	.029	.089	.191	1 10

\* The valuation is based on the following prices per pound of the essential fertilizing ingredients: Nitrogen, 15 cents; potassium oxide, 4½ cents; phosphoric acid, 5¼ cents.

## B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients—Continued.

NAME.	Analyses.	Moisture.	Nitrogen	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per 2,000 Pounds.
II. Hay and Dry Course Fodders.												
English hay, . . . . .	9	11.99	1.406	6.34	1.550	.110	.344	.240	.071	.269	.980	\$4.92
Rowen, . . . . .	12	18.52	1.608	9.57	1.486	.140	.640	.280	.084	.432	1.940	5.64
Timothy hay, . . . . .	3	11.26	1.940	4.93	1.440	.180	.620	.120	.006	.342	1.000	5.41
Red-top, . . . . .	4	7.71	1.150	4.59	1.020	.438	.571	.134	.086	.360	1.736	4.76
Kentucky blue-grass, . . . . .	2	5.34	1.320	-	1.664	.129	.398	-	.044	.431	2.863	5.95
Orchard grass, . . . . .	4	8.84	1.310	6.42	1.879	.225	.456	.297	.033	.414	2.060	6.08
Meadow fescue, . . . . .	6	8.89	.992	8.08	2.066	.301	.576	.187	.028	.399	1.637	5.30
Perennial rye grass, . . . . .	2	9.13	1.927	6.79	1.553	.307	.642	.337	.044	.559	2.262	5.90
Italian rye-grass, . . . . .	4	8.71	1.189	-	1.273	.451	.867	.321	.071	.956	2.696	* 5.32
Salt hay, . . . . .	1	5.36	1.180	-	.718	.017	.371	.335	.028	.246	-	4.46
Japanese millet (white head), . . . . .	3	10.45	1.105	5.80	1.923	.012	.465	.377	.028	.403	1.033	4.86
Japanese buckwheat, . . . . .	1	5.72	1.929	-	3.320	.349	3.418	.421	.148	.892	.378	8.91
Fodder corn, . . . . .	7	7.85	1.763	4.91	.869	.175	.606	.500	.075	.542	1.270	6.09
Corn stover, . . . . .	16	9.12	1.043	3.74	1.400	.112	.622	.384	.068	.293	1.885	4.71
Troutdale, . . . . .	1	6.06	1.440	6.53	3.666	.109	1.597	.458	.021	.546	.915	8.31
Millet hay, . . . . .	1	9.75	1.280	-	1.690	.020	.500	.460	.030	.460	1.360	5.90



## B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients — Continued.

NAME.		Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferrie Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per 1,000 Pounds.	
III. Roots, Bulbs, Tubers, etc. — Concluded.														
Beets, yellow fodder,	.	1	90.60	.192	.95	.462	.104	.045	.080	.005	.086	.015	\$1 09	
Mangolds,	.	2	87.29	.186	1.22	.363	.125	.061	.039	.005	.093	.023	1 01	
Rutabagas,	.	3	89.13	.190	1.06	.489	.070	.088	.030	.004	.123	.012	1 15	
Turnips,	.	2	89.49	.178	1.01	.385	.078	.089	.027	.009	.104	.055	0 99	
Carrots,	.	2	89.79	.147	9.22	.506	.062	.067	.023	.009	.093	.019	1 00	
Parsnips,	.	1	80.34	.217	-	.617	.006	.038	.045	.005	.187	.019	1 41	
Potatoes,	.	1	79.75	.207	.99	.294	.013	.007	.020	.003	.086	.006	0 96	
Apples,	.	2	79.91	.130	.41	.190	.030	.030	.030	.003	.010	.003	0 57	
IV. Grains and Other Seeds.														
Corn kernels,	.	12	10.83	1.822	1.53	.404	.084	.032	.206	.019	.899	.090	6 00	
Corn and cob meal,	.	20	8.96	1.498	-	.472	.059	.018	.176	.011	.571	.430	5 28	
Soja beans,	.	2	18.33	5.393	4.99	1.991	.275	.419	.909	.216	1.893	.093	19 76	
Red adzuki beans,	.	1	14.82	3.240	-	1.946	.035	.090	.210	.189	.940	.060	12 14	
White adzuki beans,	.	1	16.90	3.330	-	1.460	.190	.130	.230	.021	.970	.130	12 39	
Saddle beans,	.	1	12.36	2.120	-	2.120	.090	.259	.430	.033	1.523	.250	9 08	





## B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients — Concluded.

NAME.	VI. By-products and Refuse — Concluded.										Valuation per 2,000 Pounds.	
	Analyses.	Mixture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.		Insoluble Matter.
Cotton hulls, . . . . .	3	10.63	.750	2.61	1.080	-	.200	.280	-	.180	.060	\$3.42
Apple pomace, . . . . .	2	80.50	.927	.271	.134	.026	.037	.028	.008	.018	.009	0.82
Corn cobs, . . . . .	8	12.09	.504	.815	.598	.071	.025	.045	.009	.083	.190	2.12
Palmetto roots, . . . . .	1	11.51	.540	3.93	1.380	.345	.045	.004	.017	.157	.410	3.03
Buckwheat hulls, . . . . .	1	11.90	.490	-	.521	-	.247	.236	.020	.073	.066	2.02

*C. Analyses of Fruits.*

NAME.	Date.	Dry Matter.	Specific Gravity of Juice.	Temperature C. of Juice (Degrees).	Total Sugar in Juice.	Glucose in Juice.	Cane Sugar in Juice.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.	Per ct.			Per ct.	Per ct.	Per ct.	C. C.
Apple (Baldwin), . . .	Sept. 1,	20.14	1.065	12—15	8.09	-	-	-
Apple (Baldwin), . . .	Oct. 9,	19.66	1.065	12—15	6.25	-	-	-
Apple (Baldwin), . . .	Nov. 27,	-	1.075	12—15	10.42	-	-	-
Rhode Island Greening, . .	Sept. 1,	20.27	1.065	12—15	8.16	-	-	-
Rhode Island Greening, . .	Oct. 9,	19.68	1.066	12—15	7.14	-	-	-
Rhode Island Greening,† .	Nov. 27,	20.25	1.080	12—15	11.36	-	-	-
Pear (Bartlett), . . .	Aug. 31,	15.00	1.060	12—15	4.77	-	-	-
Pear (Bartlett), . . .	Sept. 7,	16.55	1.060	12—15	5.68	-	-	-
Pear (Bartlett), . . .	Sept. 20,	-	1.065	12—15	8.62	-	-	-
Pear (Bartlett),‡ . . .	Sept. 22,	-	1.060	12—15	8.93	-	-	-
Cranberries, . . . .	-	10.71	1.025	15	1.35	-	-	-§
Cranberries, . . . .	1878.	10.11	1.025	15	1.70	-	-	-
Early York Peach (ripe), .	-	-	1.045	25	-	1.92	6.09	45
Early York Peach (nearly ripe),	-	10.96¶	1.039	25	-	1.36	4.12	42.3
Crawford Peach (nearly ripe),	-	-	1.050	18	-	2.19	7.02	85.6
Crawford Peach (mellow), .	-	11.36¶	1.055	18	-	1.70	8.94	76
Crawford Peach (not mellow),	-	11.88¶	1.045	22	-	1.67	5.92	64

\* One part Na<sub>2</sub> CO<sub>3</sub> in 100 parts of water.

§ Free acid, 2.25 per cent.

† Picked October 9.

|| Free acid, 2.43 per cent.

‡ Picked September 7.

¶ In pulp, kept ten days before testing.

*C. Analyses of Fruits — Continued.*

[Wild and cultivated grapes.]

NAME.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter.	Glucose in Juice.	Sugar in Dry Matter.	*Sol. requir- ed to neutralize 100 parts Juice.
	<b>1876.</b>			Per ct.	Per ct.	Per ct.	C.C.
Concord, . . . . .	July 17,	1.0175	31	8.30	.645	7.77	-
Concord, . . . . .	July 20,	1.0150	31	8.10	.625	7.72	216
Concord, . . . . .	Aug. 2,	1.0200	28	9.94	.938	9.44	249
Concord, . . . . .	Aug. 16,	1.0250	28	10.88	2.000	18.38	230
Concord, . . . . .	Aug. 30,	1.0500	25	15.58	8.620	55.33	120
Concord, . . . . .	Sept. 13,	1.0670	23	17.48	13.890	79.46	55
Concord, . . . . .	Sept. 4,	1.0700	18	19.82	16.130	81.38	49.2
Wild Purple Grape, . . . . .	July 19,	1.020	31	9.00	.714	7.93	204
Wild Purple Grape, . . . . .	Aug. 4,	1.020	28	12.25	1.100	8.98	246
Wild Purple Grape, . . . . .	Aug. 16,	1.025	28	12.48	2.000	16.03	233
Wild Purple Grape, . . . . .	Aug. 30,	1.050	26	16.58	6.500	39.81	147.6
White Wild Grape, . . . . .	Aug. 31,	1.050	26	16.43	9.200	56.18	98
Hartford Prolific, . . . . .	Sept. 5,	1.060	22	17.39	13.59	79.87	88.8
Ives' seedling, . . . . .	Sept. 6,	1.070	26	20.15	15.15	75.14	88.6
Iona, . . . . .	Sept. 7,	1.080	21	24.56	15.15	61.68	144
Iona (mildewed), . . . . .	Sept. 7,	1.045	26	15.41	6.25	40.56	204.4
Agawam, . . . . .	Sept. 11,	1.075	20	20.79	17.24	82.92	94.8
Wilder, . . . . .	Sept. 11,	1.064	20	16.53	13.67	82.60	56
Delaware, . . . . .	Sept. 12,	1.080	24	23.47	17.86	76.00	74
Charter Oak, . . . . .	Sept. 12,	1.080	24	15.98	8.77	54.94	168.8
Israella, . . . . .	Sept. 16,	1.075	23	19.67	9.20	46.77	89.8
Bent's Seedling, . . . . .	Sept. 20,	1.080	21	20.65	16.13	78.11	131.8
Adirondack, . . . . .	Sept. 20,	1.065	21	15.11	13.17	87.16	68
Catawba, . . . . .	Oct. 16,	1.080	13	23.45	17.39	74.16	82
	<b>1877.</b>						
Wilder, . . . . .	Sept. 11,	1.065	23	16.41	15.15	92.32	60
Charter Oak, . . . . .	Sept. 12,	1.055	23	16.22	9.80	60.42	96
Concord, . . . . .	Sept. 13,	1.065	24	15.90	13.16	82.76	102
Concord, . . . . .	Sept. 26,	1.075	24	19.34	15.43	79.78	70.8
Eumalan, . . . . .	Sept. 24,	1.065	16	19.62	13.16	67.07	73
Wild White Grape, . . . . .	Sept. 5,	1.050	23	15.57	7.20	46.24	140.8
Wild White Grape (shrivelled), . . . . .	Sept. 20,	1.060	16	20.02	10.00	49.95	130
Wild Purple Grape (shrivelled), . . . . .	Sept. 20,	1.045	16	16.69	8.22	49.25	104

\* One part of pure Na<sub>2</sub> CO<sub>3</sub> in 100 parts water.

*C. Analyses of Fruits—Continued.*

[Effect of girdling on grapes.]

NAME AND CONDITION.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter at 100° C.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. requir- ed to neutralize 100 parts Juice.
	<b>1877.</b>			Per ct.	Per ct.	Per ct.	C. C.
Hartford Prolific, not girdled, . . .	Sept. 3,	1.045	19	12.85	8.77	68.25	111.4
Hartford Prolific, girdled, . . .	Sept. 3,	1.065	19	17.18	12.50	72.76	100
Wilder, not girdled, . . .	Sept. 3,	1.055	19	15.41	10.42	67.62	108.2
Wilder, girdled, . . .	Sept. 3,	1.075	19	17.24	14.70	85.26	88.4
Delaware, not girdled, . . .	Sept. 4,	1.065	19	15.75	11.76	74.66	101.2
Delaware, girdled, . . .	Sept. 4,	1.075	19	19.14	15.15	79.16	94.4
Agawam, not girdled, . . .	Sept. 4,	1.060	19	16.00	11.37	68.48	128.2
Agawam, girdled, . . .	Sept. 4,	1.075	19	18.45	16.21	87.42	114.8
Iona, not girdled, . . .	Sept. 6,	1.0625	22	16.00	13.51	68.31	131.4
Iona, girdled, . . .	Sept. 6,	1.085	22	21.48	15.63	72.76	125.6
Concord, not girdled, . . .	Sept. 6,	1.045	22	13.46	7.46	55.42	182.4
Concord, girdled, . . .	Sept. 6,	1.070	22	17.53	13.88	79.18	102.8
Concord, not girdled, . . .	Sept. 26,	1.065	22	17.63	13.70	78.27	86
Concord, girdled, . . .	Sept. 26,	1.080	22	24.47	19.61	80.13	76.8
Concord, not girdled, . . .	Oct. 5,	1.075	12	20.92	17.50	85.37	42
Concord, girdled, . . .	Oct. 5,	1.085	12	-	17.86	-	54
		100 PARTS OF GRAPES CONTAINED—					
	Date.						
		Ash.	Moisture.	Glucose.	Tartaric Acid.		
	<b>1889.</b>						
Concord, not girdled, . . .	Sept. 23,	-	84.60	6.24	.75		
Concord, girdled, . . .	Sept. 23,	.42	83.00	8.13	.85		
Concord, not girdled, . . .	Oct. 8,	.53	84.51	6.09	.48		
Concord, girdled, . . .	Oct. 8,	.37	82.60	8.50	.50		
	<b>1890.</b>						
Concord, not girdled, . . .	Sept. 25,	.47	86.49	7.36	1.16		
Concord, girdled, . . .	Sept. 25,	.48	84.93	9.29	1.17		
Concord, not girdled, . . .	Oct. 9,	.53	85.39	7.67	.71		
Concord, not girdled, . . .	Oct. 9,	.59	85.11	6.65	.51		
Concord, girdled, . . .	Oct. 9,	.54	85.15	9.12	.74		

\* One part of pure Na<sub>2</sub> CO<sub>3</sub> in 100 parts water.

*C. Analyses of Fruits — Continued.*

[Effect of fertilization upon the organic constituents of wild grapes.]

NAME.	Date.	Dry Matter.	Specific Gravity.	Temperature C. (Degrees).	Per Cent. of Glucose.	Per Cent. of Acids.	Remarks.
	<b>1877.</b>						
Wild Purple Grape Berries, .	Sept. 20,	16.31	-	-	8.03	-	Unfertilized.
Wild Purple Grape Berries, .	"	19.55	-	-	13.51	-	Fertilized.
Wild Purple Grape Juice, .	"	-	1.045	16	8.22	9.840	Unfertilized.
Wild Purple Grape Juice, .	"	-	1.065	16	13.51	1.149	Fertilized.
Wild White Grape Berries, .	"	20.02	-	-	-	-	Unfertilized.
Wild White Grape Berries, .	"	21.65	-	-	-	-	Fertilized.
Wild White Grape Juice, .	"	-	1.060	16	10.00	1.846	Unfertilized.
Wild White Grape Juice, .	"	-	-	-	14.29	.923	Fertilized.

[Effect of fertilization upon the ash constituents of grapes.]

NAME.	Date.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Remarks.
	<b>1876.</b>								
Wild Purple Grapes, .	Sept. 13,	50.93	.15	22.23	5.59	.79	17.40	2.93	Unfertilized.
Wild Purple Grapes, .	Sept. 20,	62.65	.85	14.24	3.92	.53	13.18	4.63	Fertilized.
Concord Grapes, .	July 7,	41.73	5.04	25.03	7.80	.55	18.48	1.37	Unfertilized.
Concord Grapes, .	July 17,	47.34	1.13	24.31	-	.75	21.33	.43	Unfertilized.
Concord Grapes, .	Aug. 18,	51.14	3.19	16.20	6.38	.65	20.77	1.67	Unfertilized.
Concord Grapes, .	Sept. 13,	57.15	4.17	11.30	3.10	.40	12.47	11.62	Unfertilized.
	<b>1878.</b>								
Concord Grapes, .	Oct. 3,	64.65	1.42	9.13	3.63	.50	14.37	5.80	Fertilized.

*C. Analyses of Fruits—Concluded.*

[Ash analyses of fruits and garden crops.]

NAME.	Ash.	100 PARTS OF ASH CONTAINED—						
		Potash.	Soda.	Lime.	Magnesia.	Ferrie Oxide.	Phosphoric Acid.	Insoluble Matter.
Concord Grape (fruit), . .	-	51.14	3.19	16.20	6.38	.65	20.77	1.67
Unfermented juice, . .	-	50.85	.48	3.69	4.25	.10	6.43	.90
Fermented juice, . .	-	40.69	-	6.85	6.24	-	9.04	-
Skins and pulp, . . .	-	7.70	.42	57.36	8.80	.08	24.40	1.82
Seeds, . . . . .	3.08	6.71	-	-	3.03	-	17.20	.29
Stems of grapes, . . .	4.09	20.91	-	20.20	8.45	-	17.75	2.09
Young branches,* . .	-	24.71	.94	40.53	10.66	1.08	17.16	4.92
Wood of vine,† . . .	2.97	22.57	-	9.72	4.28	-	14.07	23.84
Concord Grapes, 1891,‡ . .	.55	49.76	-	3.50	2.53	1.19	13.56	2.01
Clinton Grape (fruit), . .	-	58.45	3.51	13.34	7.37	.90	18.19	-
Baldwin Apple, . . . .	-	63.54	1.71	7.28	5.52	1.08	20.87	3.68
Strawberry (fruit),§ . . .	.52	49.24	3.23	13.47	8.12	1.74	18.50	5.66
Strawberry (fruit),   . . .	-	58.47	-	14.64	6.12	3.37	17.40	-
Strawberry vines, . . . .	3.34	10.62	13.35	36.63	3.83	6.91	14.48	14.17
Cranberry (fruit), . . . .	.18	47.96	6.58	18.58	6.78	-	14.27	-
Cranberry vines, . . . .	2.45	12.98	3.27	16.49	10.33	3.35	10.94	34.04
Currants, red, . . . . .	.47	47.68	4.02	18.96	6.23	1.20	21.91	-
Currants, white, . . . .	.59	52.79	3.00	17.08	5.68	2.67	18.78	-
Crawford Peach, sound, . .	-	74.46	-	2.64	6.29	.58	16.02	-
Crawford Peach, diseased,¶ .	-	71.30	-	4.68	5.49	.46	18.07	-
Branch, sound, . . . .	-	26.01	-	54.52	7.58	.52	11.37	-
Branch, diseased,¶ . .	-	15.67	-	64.23	10.28	1.45	8.37	-
Carnation Pinks (whole plant),**	8.80	38.07	12.84	18.64	3.98	.34	5.23	.24
Asparagus stems, . . . .	-	42.94	3.58	27.18	12.77	1.22	12.31	.08
Asparagus roots, . . . .	-	56.43	5.42	16.48	7.57	-	15.09	3.67
Onions, . . . . .	-	38.51	1.90	8.20	3.65	.58	15.80	3.33

\* With tendrils and blossoms.

§ Wilder.

† One year old.

|| Downing.

‡ Nitrogen in dry matter, .96 per cent.

¶ Yellows.

\*\* Nitrogen in dry matter, 1.15 per cent.

*D. Analyses of Sugar-producing Plants.*

[Composition of sugar beets raised upon the college grounds during the season of 1870 and 1871.]

NAME.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Sugar.	Non-saccharine Substances.
Electoral, . . . . .	Sept. 10,	14	12.30	1.75
Imperial, . . . . .	" 12,	15	12.59	2.41
Vilmorin, . . . . .	" 13,	14.5	12.95	1.55
Imperial, . . . . .	" 18,	14	10.79	3.21
Imperial, . . . . .	Oct. 11,	15	12.05	2.95
Electoral, . . . . .	" 16,	15	12.22	2.78
Vilmorin, . . . . .	" 18,	16	13.13	2.87
Imperial, . . . . .	Nov. 14,	15	11.60	3.34
Vilmorin, . . . . .	" 21,	15.5	13.12	2.38
Vienna Globe,* . . . .	Sept. 19,	11	8.00	3.00
Common Mangold,* . . .	" 19,	9	5.00	3.97

\* Fodder beets.

[Percentage of sugar in different varieties of sugar beets grown on college farm during the season of 1882.]

NAME.	Source of Seed.	Weight in Pounds.	Per Cent. of Sugar in Juice.
I. Vilmorin, . . . . .	Saxony, .	$\frac{3}{4}$ to $\frac{7}{8}$	15.50
II. Vilmorin, . . . . .	Saxony, .	$\frac{3}{4}$ to 1	15.61
I. White Imperial, . . . .	Saxony, .	$\frac{3}{4}$ to $1\frac{1}{4}$	14.20
II. White Imperial, . . . .	Saxony, .	$1\frac{1}{4}$ to 2	10.27
New Imperial, . . . . .	Saxony, .	$1\frac{1}{4}$ to $1\frac{3}{4}$	13.80
I. White Magdeburg, . . . .	Saxony, .	$1\frac{1}{4}$ to 2	13.10
II White Magdeburg, . . . .	Silesia, .	$1\frac{1}{2}$ to $1\frac{3}{4}$	10.06
Quedlinburg, . . . . .	Saxony, .	$1\frac{1}{2}$ to $1\frac{3}{4}$	13.44
White Silesian, . . . . .	Silesia, .	$1\frac{1}{4}$ to $1\frac{1}{2}$	9.72

*D. Analyses of Sugar-producing Plants — Continued.*

[Effect of soil and fertilization on Electoral sugar beets.\*]

SOIL.	MANURE.	Specific Gravity Brix (Degrees).	Per Cent. of Sugar in Juice.	Non-saccharine Substances.	Cane Sugar in Soluble Matter.
Sandy loam, .	Fresh yard-manure, .	16.5	12.50	4.00	75.08
Clayish loam, .	Fresh yard-manure, .	15.5	11.05	4.45	71.30
Warm alluvial, .	Yard-manure and chemicals, . . .	12.75	9.17	3.58	71.92
Warm alluvial, .	Fresh hog-manure, .	13.5	9.53	3.97	70.06
Light, sandy soil,	No manure, . . .	18.5	13.73	4.77	74.21
Alluvial soil, .	Brighton fish, . .	14.5	11.15	3.35	76.90
Heavy soil, .	Yard-manure, . .	12.25	8.15	4.10	66.53
-	-	13.5	9.90	3.60	73.33

\* Not raised on college farm (Connecticut valley).

[Effect of fertilization on sugar beets.\*]

FERTILIZERS.	PERCENTAGES OF SUGAR IN JUICE.		
	Freeport.	Electoral.	Villmorin.
Fresh horse-manure, . . . .	11.96	9.42	7.80
Blood guano without potash, . .	10.99	10.10	10.20
Blood guano with potash, . . .	12.55	13.24	10.50
Kainite and superphosphate, . .	13.15	12.16	10.50
Sulphate of potash, . . . .	14.52	14.32	12.78
Second year after stable-manure, .	13.49	12.78	12.19

\* All were grown on the same soil, — sandy loam (college).



*D. Analyses of Sugar-producing Plants—Continued.*

[Effect of different modes of cultivation on Electoral sugar beets.]

LOCALITY OF BEET-FIELD.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Cane Sugar.	Non-saccharine Substances.
1. Sing Sing, N. Y., . . .	1872-73	11	7.80	3.20
2. Washington, N. Y., . . .	"	14	10.97	3.03
3. South Hartford, N. Y., . . .	"	15	11.70	3.30
4. Greenwich, N. Y., . . .	"	12	9.50	2.50
5. Frankfort, N. Y., . . .	"	13.5	11.00	2.50
6. Albion, N. Y.,* . . .	"	18	15.10	2.90
Albion, N. Y.,† . . .	"	14	9.70	4.30

\* From beets weighing from 1½ to 2 pounds. † From beets weighing from 10 to 14 pounds.

1. Soil, loam resting on clayish hard-pan, had been for several years in grass. Tomatoes had been the preceding crop. Five hundred pounds of a phosphatic blood guano were applied before planting.

2. Soil, a clayish loam, had been ploughed seven inches deep. A liberal amount of rotten sheep-manure was placed in trenches and covered by running two furrows together, thus forming a ridge on which the seed were planted.

3. Soil, a gravelly loam, which had been richly manured with stable compost and twice ploughed before planting.

4. Soil, a sandy loam, underlaid by fine sand. The seed were planted on ridges, which covered trenches containing a little rotten stable-manure.

5. No details of modes of cultivation received.

6. Soil, a dark, reddish-brown, rich, deep, sandy loam. Clover had been raised for two years previous to a crop of carrots, which preceded the sugar beets. The beets were the second crop after the application of twenty loads of stable-manure per acre.

*Composition of Canada-grown Sugar Beets.*

[1872 and 1873.]

WHERE GROWN.	Weight of Roots.	Specific Gravity of Juice (Brix).	Temperature of Juice.	Per Cent. of Cane Sugar in Juice.
Echaillon de Montreal, . . .	2 to 2½ lbs.	15.4°	64° F.	11.38
Riviere du Loup, . . .	2 to 3½ lbs.	14.5°	63° F.	10.20
Chambly, . . .	2 to 2½ lbs.	13.2°	63° F.	9.02
Maskinonge, . . .	2 to 3 lbs.	13.4°	63° F.	8.83

*D. Analyses of Sugar-producing Plants — Continued.*

[Early Amber Cane.]

DATE.	CONDITION OF CANE.	Brix Saccharometer (Degrees).	Temperature C. (Degrees).	Glucose.	Cane Sugar.	Soda solution required to neutralize 100 parts of Juice.	Solids.
				Per ct.	Per ct.	C. C.	Per ct.
<b>1879.</b>							
Aug. 15,	No flower stalks in sight,* . . .	4.2	27	2.48	None.	6.8	7.93
Aug. 16,	No flower stalks in sight,* . . .	5.8	24	4.06	None.	9.0	11.10
Aug. 20,	Flower stalks developed,* . . .	7.9	24	3.47	2.15	7.0	13.00
Aug. 24,	Flowers open,* . . .	8.7	23	3.70	3.00	4.0	14.07
Aug. 27,	Plants in full bloom,* . . .	10.0	25	3.65	4.13	10.0	15.48
Aug. 30,	Seed forming,* . . .	9.5	30	4.00	3.81	9.5	16.14
Sept. 2,	Seed in milk,* . . .	10.7	27	3.85	4.41	9.5	15.85
Sept. 9,	Seeds still soft,* . . .	12.1	22	3.21	6.86	9.5	26.13
Sept. 9,	Stripped on Sept. 2,* . . .	12.8	22	3.77	6.81	9.5	26.75
Sept. 18,	Left on field without stripping,* . .	13.2	22	3.57	7.65	-	-
Sept. 18,	Tops removed,* . . .	13.8	22	3.16	8.49	-	-
Sept. 18,	Tops and leaves removed on Sept. 9,*	11.5	22	3.16	5.85	-	-
Sept. 18,	Tops removed; left on field 9 days,*	12.8	22	10.00	.60	-	-
Sept. 21,	Juice from the above,* . . .	13.0	21	-	-	-	-
Sept. 23,	Juice from the above,* . . .	15.0	18	-	-	-	-
Sept. 25,	Left on field 3 weeks,† . . .	19.8	21	11.91	6.27	-	-
Sept. 28,	Left on field 3 weeks,† . . .	17.8	12	16.60	-	-	-
Oct. 4,	Left on field 3 weeks,† . . .	16.1	17	8.62	6.16	12.0	-
Oct. 7,	Freshly cut. Ground with leaves,†	16.7	20	4.16	9.94	6.8	-
Oct. 8,	Freshly cut. Stripped two weeks,†	12.8	17	5.16	5.27	7.0	-
Oct. 9,	Freshly cut. Stripped two weeks,†	18.4	17	7.57	-	10.6	-
Oct. 14,	Several weeks old,† . . .	18.2	15	10.42	-	10.4	-
Oct. 18,	Several weeks old,† . . .	15.1	23	7.57	-	-	-
Oct. 19,	Several weeks old,† . . .	15.5	15	9.22	-	13.6	-
Oct. 22,	Several weeks old,† . . .	16.2	16	8.30	-	-	-
Oct. 23,	Several weeks old,† . . .	18.3	17	11.30	5.5	14.0	-
Oct. 24,	Several weeks old,† . . .	16.6	15	8.63	-	9.0	-
		100 PARTS OF CANE CONTAINED —					
		Moisture.	Glucose.	Cane Sugar.	Total Sugar.		
<b>1889.</b>							
October,	Early Tennessee sorghum, mature,	77.43	1.79	3.21	5.00	Grown on station grounds.	
October,	Price's new hybrid, ripe, . . .	77.80	2.92	3.78	6.70		
October,	Kansas orange, green, . . .	80.67	2.38	3.63	6.01		
October,	New orange, green, . . .	78.30	2.96	3.85	6.81		
October,	Honduras, green, . . .	77.55	3.08	4.01	7.09		

\* Raised on the college farm.

† Raised by farmers in the vicinity of the college.

*D. Analyses of Sugar-producing Plants — Concluded.*

[Composition of the juices of corn stalks and melons.]

VARIETY.	Specific Gravity.	Temperature C. (Degree).	Glucose.	Cane Sugar in Juice.	Solids.
Northern corn,* . . . .	1.023	27	Per ct. 4.35	Per ct. 0.28	Per ct. 15.18
Black Mexican sweet corn,† . .	1.048	27	2.06	7.02	17.44
Evergreen sweet corn,‡ . . .	1.052	—	4.85	5.70	20.38
Common sweet corn,‡ . . .	1.035	—	6.60	None.	—
Common yellow musk-melon,§ .	1.040	26	1.67	2.65	—
White-flesh water-melon, . .	1.025	18	2.91	2.16	—
Red-flesh water-melon, . . .	1.025	22	3.57	2.18	—
Red-flesh water-melon, . . .	1.025	19	3.84	1.77	—
Nutmeg musk-melon,   . . .	1.030	19	3.33	2.11	—
Nutmeg musk-melon,¶ . . .	1.050	20	2.27	5.38	—
Nutmeg musk-melon,** . . .	1.030	19	2.50	1.43	—

\* Tassels appearing.

† Ears ready for the table.

‡ Kernels somewhat hard.

§ Fully ripe.

|| Not ripe.

¶ Ripe.

\*\* Over-ripe.

*E. Analyses of Dairy Products.*

	Analyses.	Solids.			Fat.			Curd.			Salt.			Ash.
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	
Whole milk, . . . . .		899	18.27	10.53	13.60	7.54	2.48	4.00		3.20				.70
Skim milk, . . . . .		76	10.40	7.68	9.50	1.02	.20	.46		3.53				.80
Buttermilk, . . . . .		18	9.86	7.40	8.16	.38	.15	.21		2.78				.80
Cream (from Cooky (Creamer)), . . . . .		94	29.35	21.30	25.50	20.90	13.74	17.70		-				.62
Butter, . . . . .		24	92.89	87.05	89.17	89.05	81.43	83.88	.89	.51	6.46	3.61	4.80	-
Whole-milk cheese (Jersey),* . . . . .		1	-	-	62.64	-	-	37.32	-	22.13	-	-	-	3.39
Whole-milk cheese,* . . . . .		1	-	-	64.17	-	-	34.34	-	26.66	-	-	-	3.14
Cheese from milk skimmed after twelve hours' standing,* . . . . .		1	-	-	62.70	-	-	27.81	-	30.37	-	-	-	4.52
Cheese from milk skimmed after twenty-four hours' standing,* . . . . .		1	-	-	57.76	-	-	23.42	-	31.66	-	-	-	2.35
Cheese from milk skimmed after thirty-six hours' standing,* . . . . .		1	-	-	56.05	-	-	17.67	-	33.24	-	-	-	5.14
Cheese from milk skimmed after forty-eight hours' standing,* . . . . .		1	-	-	54.59	-	-	15.77	-	34.94	-	-	-	3.88
Cheese from skim-milk, with addition of buttermilk,* . . . . .		1	-	-	51.62	-	-	16.36	-	29.63	-	-	-	4.64
Genuine oleomargarine cheese,* . . . . .		1	-	-	62.10	-	-	31.66	-	25.94	-	-	-	4.50

\* From analyses made in 1875.

*E. Salt for Meat Packing and Dairy Purposes.*

KIND AND SOURCE.	Moisture, 100° C.	Sodium Chloride.	Calcium Sulphate.	Calcium (Chloride.	Magnesium Chloride.	Sodium Sulphate.	Magnesium Sulphate.	Insoluble Matter.	Remarks.
Rock salt of Petite Anse, La.,	.330	98.882	.782	.004	.003	.070	.070	.	Sent on for examination. Sulley to acid : trace.
Rock salt of Neyba, San Domingo, W. I.,	.300	98.330	1.480	.080	.080	.	.	.	
Solar salt, Onondaga, N. Y.,	2.500	96.004	1.315	.002	.089	.	.	.	
Solar salt, Rocking Valley, O.,	2.130	97.012	None.	.234	.089	.	.	.	
Solar salt, Saginaw Valley, Mich.,	3.344	95.813	.316	.356	.140	.	.	.	
Solar salt from Kansas,	4.960	93.080	1.220	.	.240	.360	.180	.	
Solar salt, Lincoln County, Neb.,	1.200	98.130	.250	.	.080	.390	None.	.	
Common fine and boiled salt, Onondaga, N. Y.,	3.000	96.383	1.355	.156	.136	.	.	.	
Common fine and boiled salt, Portsmouth, Mich.,	6.762	90.882	.805	.974	.781	.	.	.	
Common fine and boiled salt, Mason City, O.,	3.470	95.799	.	.014	.041	.	.	.	
Dairy and table salt, Ashton's (English),	0.760	97.652	1.430	.	.000	.	.048	.080	
Onondaga dairy salt,	0.700	97.832	1.263	.	.037	.026	.023	.085	
Fine salt, Bulletin 26, I.,	3.280	95.091	1.487	.032	.076	.	.	.028	
Fine salt, Bulletin 26, II.,	4.591	94.012	1.177	.143	.049	.	.	.082	
Fine salt, Bulletin 26, III.,	4.616	94.236	.990	.071	.036	.	.	.	
Dairy salt, sent on from Amherst, Mass.,	0.145	96.620	1.009	.189	.065	.	.	.073	
Ashton salt (sent on),	.760	97.650	1.430	.	.060	.	.060	.060	
Onondaga factory-filled (sent on),	.600	96.260	.910	.	.	.030	.060	.120	
Dairy salt, sent on from Amherst,	.503	98.202	.877	.168	.046	.	.	.203	
Rock salt from Rietsof salt mine,	2.600	95.940	.420	.320	.010	.	.	.700	
Royal salt,	.860	97.877	1.108	.016	.010	.	.	.102	
Excelsior salt,	.320	98.049	1.644	.013	.014	.	.	.020	
Genesee salt,	.295	98.513	1.160	.010	.012	.	.	.010	
Genesee salt,	.235	98.583	1.137	.045	.020	.	.	.	
Higley salt,	.200	98.575	1.135	.029	.055	.	.	.	
Highley Eureka salt,	.455	98.891	.806	.203	.045	.	.	.	
Worcester refined salt,	.365	97.335	1.376	.067	.027	.	.	.	



## METEOROLOGY.

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1891.

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The meteorological observations have been continued as in previous years. The temperature, the force and the direction of the wind and the amount of cloudiness are recorded each day at 7 A.M., 2 P.M. and 9 P.M. During the summer months the reading of a wet-bulb thermometer takes place at the same times. Records are also taken of maximum and minimum temperatures, rainfall, and of casual meteorological phenomena.

Monthly and annual reports are sent to the headquarters of the signal service at Washington, D. C., and to the New England Meteorological Society. During the summer months partial monthly reports have been furnished also for the use of the secretary of the State Board of Agriculture.

At the beginning of the year there were nine inches of snow on the ground. The total snowfall of the season after January 1 amounted to fifty-eight inches. The heaviest snow-storm during the time occurred January 25, measuring thirteen inches. A storm giving twelve inches of snow occurred on the 3d and 4th of March. The last snow of this part of the season fell on the 2d and 3d of April. Sleighing was good most of the time until the 10th of March. A snow-storm on the 26th of November amounted to one and one-half inches. The snowfall during December was very light. The precipitation of moisture (rain and snow) during the year was below the average and unevenly distributed.

The largest amount of water falling in one month was 6.61 inches, January; the smallest amount 1.98 inches, November. The heaviest storm of the year occurred from

the 2d to the 4th of June, with 2.92 inches of rainfall. The largest amount of rain falling in any one day was 1.73 inches, June 2.

The rainfall during April and May was light, otherwise the early part of the season was favorable for farm crops. The large number of rainy days during July and August interfered to some extent with haying and harvesting. The rainfall for the months September, October and November was much below the usual average. A scarcity of water was seriously felt in many localities of this vicinity.

The last heavy frost of the season occurred on the 19th of May; there was a slight one on the 5th of June. No frost was noticed in the autumn before October 10.

The mean annual temperature for the year was 47.62° F., which is slightly above the average. The monthly average temperatures did not vary much from those of former years except during September, which was considerably warmer than usual.

The highest temperature for the year, 93° F., occurred June 16; the lowest, — 5.5, February 15.

The prevailing wind during six months of the year came from the north-east. It was north-west during April and May, south during July, and south-east during September, November and December.

During the year there were one hundred and forty-five days recorded as "cloudy," seventy-nine as "cloudless." The greatest number of cloudy days, fifteen, occurred in January, and the greatest number of cloudless days, eight, in November and December.



*Summary of Meteorological Observations, 1891.*

TEMPERATURE, DEGREES FAHRENHEIT.										RELATIVE HUMIDITY, PER CENT.				PRECIPITATION, INCHES.	
	7 A. M.	9 P. M.	Mean.	Maxi- mum.	Mini- mum.	Range.	Absolute Maxi- mum.	Date.	Absolute Mini- mum.	Date.	7 A. M.	9 P. M.	Mean.	Depth of Water.	Date of Greatest Fall.
January,	21.7	30.3	26.6	41.5	14.4	27.1	50.5	22d	-1.0	10th	-	-	-	6.61	22d
February,	23.4	32.1	27.2	47.9	10.4	37.5	53.5	25th	-5.5	16th	-	-	-	3.84	9th, 10th
March,	27.2	37.7	32.1	44.5	10.2	34.3	55.5	29th	-1.0	2d	-	-	-	2.99	8th, 9th
April,	41.6	55.2	45.4	64.0	10.8	33.2	77.0	30th	18.0	6th	-	-	-	2.74	11th
May,	49.3	64.4	53.4	68.1	37.4	37.0	86.0	10th	25.0	6th	79.0	56.2	71.5	1.82	29th
June,	56.6	74.6	62.8	77.1	49.3	27.8	93.0	16th	34.5	5th	87.7	60.8	80.2	4.61	2d
July,	61.7	74.2	64.4	76.2	58.6	17.6	99.0	13th	42.0	28th	87.4	62.4	81.9	5.09	30th
August,	63.9	76.3	66.6	77.4	58.8	18.6	90.0	11th	46.0	1st	90.9	66.1	86.6	3.67	28th
September,	57.8	73.0	61.7	75.0	50.5	24.5	89.0	18th	37.0	9th	95.7	64.4	87.4	2.22	29th
October,	41.4	56.8	46.0	67.2	33.0	34.2	87.0	4th	21.0	29th	88.4	62.6	82.5	2.56	20th
November,	32.3	45.1	35.2	56.0	14.6	41.4	63.0	11th	4.0	30th	-	-	-	1.98	16th, 17th
December,	31.0	42.3	35.2	52.9	12.8	40.1	58.5	4th	9.0	17th	-	-	-	4.55	29th, 30th
Sums,	510.9	692.0	556.2	747.8	380.8	367.0	892.0	-	229.0	-	529.1	372.5	490.1	43.8	-
Mean,	42.57	55.17	46.36	62.32	31.73	30.68	74.33	-	19.08	-	86.18	62.08	81.68	77.80	-

*Miscellaneous Phenomena, — Dates.*

	Frost.	Snow.	Rain.	Thunder- storms.	Lunar Halos.	Solar Halos.
<b>1891.</b>						
January, .	-	1, 5, 14, 17, 18, 25, 27, 29.	1, 11, 12, 17, 18, 22, 29, 31.	2,	15,	-
February, .	-	7, 8, 9, 20, 26,	1, 3, 9, 10, 16, 17, 18, 21, 25.	-	15, 19,	6, 28.
March, . .	-	3, 4,	8, 9, 12, 13, 21, 22.	-	18,	27, 31.
April, . .	-	2, 3,	11, 14,	15, 18,	-	-
May, . .	19,	-	3, 6, 15, 16, 21, 29.	11, 26,	20,	2.
June, . .	5,	-	4, 17, 18, 19, 21, 22.	2, 3,	11,	-
July, . .	-	-	4, 7, 8, 18, 24, 28, 29, 30.	15, 25,	-	-
August, . .	-	-	4, 5, 21, 22, 23, 24, 26, 27.	7, 12, 15, 18, 23.	-	-
September, .	-	-	5, 6,	13, 29,	11,	-
October, .	10, 12, 16, 17, 24, 25, 29, 30.	-	7, 8, 13, 26, 27,	20,	-	-
November, .	3, 4, 5, 7, 8, 13, 14, 15, 19, 20, 21, 26.	26,	10, 11, 16, 17, 23, 26, 27, 28.	-	19,	-
December, .	1, 12, 13, 28, 29.	-	4, 7, 15, 16, 22, 23, 24, 26, 29, 30.	-	9, 19,	-

AMHERST, MASS.

C. A. GOESSMANN,

*Director.*

## ANNUAL REPORT OF FRANK E. PAIGE,

TREASURER OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION,

*For the Year ending Dec. 31, 1891.*

## RECEIVED.

Cash on hand from last year, . . . . .	\$343 86
Cash from State Treasurer, appropriation, . . . . .	10,000 00
Cash from fertilizer account, . . . . .	2,250 00
Cash from expense, . . . . .	325 00
Cash from farm, . . . . .	978 71
	<hr/>
	\$13,897 57

## EXPENDED.

Cash paid salaries, . . . . .	\$5,243 31
Cash paid laboratory supplies, . . . . .	738 43
Cash paid printing and office expenses, . . . . .	680 75
Cash paid farmer and farm labor, . . . . .	2,330 24
Cash paid farm supplies, . . . . .	1,505 47
Cash paid incidental expenses, . . . . .	528 66
Cash paid construction and repairs, . . . . .	138 77
Cash paid expense of board of control, . . . . .	138 63
Cash paid fertilizer account, . . . . .	2,590 00
Cash on hand, . . . . .	8 31
	<hr/>
	\$13,897 57

SUMMARY OF THE PROPERTY OF THE MASSACHUSETTS STATE  
AGRICULTURAL EXPERIMENT STATION.*(Dec. 31, 1891.)*

## Farm :

Live stock, . . . . .	\$821 00
Tools, implements and machinery, . . . . .	935 95
Produce on hand, . . . . .	607 20
Fertilizers, . . . . .	72 67

## Chemical Laboratory :

Laboratory inventory, . . . . .	2,740 27
Office furniture, . . . . .	1,617 00

## Agricultural and Physiological Laboratory :

Furniture, herbariums, library (first floor), . . . . .	734 75
Instruments, apparatus, etc. (first floor), . . . . .	691 20
Furniture (second floor), . . . . .	394 52
Instruments, apparatus, etc. (second floor), . . . . .	369 90
Buildings, land, etc., . . . . .	32,202 00
Total of inventory, . . . . .	<hr/>
	\$11,186 46

BOSTON, MASS., Jan. 14, 1892.

This is to certify that I have examined the books and accounts of Frank E. Paige, Treasurer of the Massachusetts Agricultural Experiment Station, for the fiscal year ending Dec. 31, 1891, and find them correct, and all disbursements properly vouched for, with a balance in the treasury of three dollars and thirty-one cents, which is shown to be in bank.

W. R. SESSIONS,

Auditor.

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